CAPR Five Year Program Review

2007

Department of Chemistry and Biochemistry

Part 1. Self Study

a. Summary of Achievements (2002-2007)

Over the last several years, considerable progress toward the goals outlined in our CAPR Review of 2002 has been made. In some cases the goals were revised, and a few new initiatives were developed. The 2002 Five Year Plan anticipated an increase in the student population and set out plans for changes in curriculum, space, and resources to accommodate the increase. The plans also took into account changes in the field and the need to ensure that our students were graduating with the theoretical and practical knowledge needed for employment or further education. The 2002 Plan also identified, due to impending retirements, a critical need to hire more tenure track faculty. This summary delineates the key areas from the 2002 Plan and the efforts made over the last five years toward implementation.

Curriculum

In accordance with the 2002 Plan, we incorporated biochemistry into the BS Chemistry degree as recommended by our accrediting agency, the American Chemical Society (ACS). We made changes to our analytical chemistry curriculum, although not exactly as originally outlined. We developed a new intermediate level lecture/laboratory course that applies analytical techniques to forensic science (Chem 3200). This course is now a requirement for new Forensic Science Options in both Chemistry and Biological Science and for our revised BA Chemistry degree. It also serves as an elective for the B.S. Chemistry degree. We did not develop a two quarter physical chemistry series for the BA Chemistry and BS Biochemistry degree programs but instead modified this goal. It was decided that the three quarter physical chemistry requirement would remain in place for the BS Biochemistry program. A one quarter physical chemistry course emphasizing principles used in biological science and biochemistry was developed for the BA Chemistry program and a planned BA Biochemistry degree (see below). The new one quarter course is called Biophysical Chemistry (Chem 3501) and was offered for the first time in Fall, 2007. We did not develop an Advanced Structure Elucidation course, as proposed in the 2002 Plan, but we did acquire the FT-Nuclear Magnetic Resonance (FT-NMR) instrument key to implementing such a course (see below). Use of this instrument has been incorporated into several of our existing courses.

As planned in our 2002 Review, we streamlined the BA Chemistry degree program to make it more attractive to students planning a minor in another field. We eliminated the three quarter physical chemistry requirement and instead required the new Biophysical Chemistry course. We also reduced the calculus requirement to two quarters and added a biochemistry course and the new forensic science analytical course to the curriculum. We replaced the BA Chemistry, Option in Biochemistry degree program with a new BA Biochemistry degree and modified the degree requirements. The calculus and physical chemistry requirements were reduced as in the BA Chemistry degree. The requirement for Quantitative Analysis (Chem 2200) was dropped, and a requirement for Advanced Biochemistry Lab (Chem 4431) was added. A requirement for two biochemistry or biology electives was also added. These changes preserved the training in chemistry and biochemistry while reducing the total number of units, making the BA

degrees attractive for students who wish to combine a major in chemistry or biochemistry with a major or minor in another discipline and thus increase opportunities in non-traditional and interdisciplinary careers. We also explored the idea of creating new options for our degree programs and implemented a new degree, BS Chemistry with a Forensic Science Option, in 2004. Finally, we expanded the courses acceptable for the Minor in Chemistry to include Environmental Chemistry (Chem 4601) and Biochemistry (Chem 3400 or Chem 4411).

Just prior to the 2002 Review, the Department of Biological Science reduced the organic chemistry requirement for its BS degree program. Our outside reviewer expressed concern over this and mentioned that the trend in other institutions was toward more chemistry in Biology curricula. He suggested that we enter into discussions with the Department of Biological Science to try to restore the higher level organic chemistry requirement. Recently, that department established a BS Biological Sciences, Option in Cell and Molecular Biology program. The new degree option restores the year long organic chemistry requirement and also requires two quarters of biochemistry.

Faculty

At the time of the 2002 Review, the department was down from ten full time tenure track faculty (in 1997) to six regular faculty members and four retired members in the Faculty Early Retirement Program (FERP). Since Fall, 2002 three additional faculty retired, one passed away, and five new tenure track faculty were hired. With the five new tenure track hires we were able to maintain a reasonable balance of organic, physical, analytical and biochemistry expertise in the department and also find several individuals whose research involves Nuclear Magnetic Resonance (NMR). Several of the new faculty collaborated on a grant proposal to the National Science Foundation (NSF) to fund a high field NMR. The proposal was successful and allowed purchase of a new instrument in 2005 (see below). The new faculty have all established active research programs. Currently there are seven full time tenure track faculty and one FERP member in the department. All seven full time faculty routinely supervise student research projects. Two new tenure track searches have been approved for 2007-08, one for a physical chemist and one for a biochemist.

Equipment and Facilities

The 2002 Plan noted that the proposed hiring of research active faculty would lead to the need for additional research and equipment space, which is short supply in the Science building. To provide additional space for the new research active faculty hired over the last five years, the College returned to the Chemistry and Biochemistry a research lab that had been re-assigned to another department and a classroom lab was converted to research space. The shortage of research and equipment space is an ongoing problem in the College of Science that affects a number of departments.

Over the last five years, the department has made progress in obtaining new instrumentation. An NSF-Major Research Instrumentation Grant for $435,523 was awarded

for the purchase of a High-Field Multi-Nuclear FT-NMR spectrometer in 2005. This instrument is vital to the department for structure elucidation in research and has been utilized in several laboratory classes, including Instrumental Methods of Analysis (Chem 4240) and Organic Chemistry (Chem 3301, 3302, 3303). The department also acquired a second high performance liquid chromatography (HPLC) apparatus with gradient capabilities, a fast protein liquid chromatography (FPLC) instrument, an optical microscope, a uv/vis spectrometer with a temperature controller, a fermenter, and a chromatotron radial chromatography instrument. Our atomic absorption instrument was updated with a FIAS and gold amalgam for atomic absorption spectroscopy of mercury. We also obtained College of Science Program Enhancement Funds to upgrade the software on our HPLC apparatuses and purchase a Table Top Ultracentrifuge. New equipment obtained during this period also included two -80°C freezers, two incubating shakers, a water deionizer, and a probe sonicator.

Some improvements were also made to instrumentation used in the classroom. The biochemistry teaching labs were upgraded with a new uv/vis spectrometer, quartz cuvettes, an isoelectric focusing cell and new pipettors through College of Science Program Enhancement Funds. The pH meters used in Quantitative Analysis and Biochemistry Labs were also refurbished. Additional improvements in small equipment are needed for the teaching laboratories and some larger items will likely need to be replaced in the near future (e.g. the FT-IR spectrometer). As proposed in the 2002 Plan, the Spartan Molecular Modeling license for our department computing facility was updated for use in the organic chemistry course series.

Research and Other Professional Activities

Research activity during the past five years has increased dramatically. Dr. Groziak, Dr. Kim, Dr. Kotchevar, and Dr. Luibrand were co-principle investigators on the NSF-MRI grant for purchase of the NMR spectrometer. Dr. Groziak has been the recipient of a National Institutes of Health (NIH)-AREA grant. Dr. Kim was awarded an NSF grant and an NIH-MBRS grant. Dr. Andrews has obtained funding from CALFED and CICORE (NOAA-funded). Dr. Andrews and Dr. LeDuc obtained instrument time grants from Stanford Synchroton Radiation Lab (SSRL) and the Advanced Light Source at Lawrence Berkeley National Laboratory. Drs. Groziak, Kim, Kotchevar, and Sommerhalter have held faculty seed grants from the CSU Program for Education and Research Biotechnology (CSUPERB). Drs. Andrews, Groziak, Kim, Kotchevar, LeDuc, McPartland, and Sommerhalter have all held multiple Faculty Support Grants (RSCA). Cumulatively, the Department of Chemistry and Biochemistry faculty published 18 papers in the last five years.

The increase in department research has led to an increase in student involvement in undergraduate research and an increase in the number of Plan A (research track) Master of Science (MS) degree students. During the past five years, approximately 85 undergraduates have participated in undergraduate research with a faculty advisor. Approximately 30 MS students conducted on-campus research with a faculty member. This research activity has led to 68 student presentations at national and local scientific meetings.

The Faculty of Chemistry and Biochemistry Department also are very active in external professional activities. Dr. Andrews has served as chair of the SSRL Users Organization and organized an SSRL User's Conference in the Fall of 2005. She is also the CSUEB representative to the Bay Delta Science Consortium. Dr. Groziak has been a member of the Strategic Planning Council for CSUPERB and a member of the Faculty Consensus Group for CSUPERB. He is also a member of the American Chemical Society Division of Chemical Education ORG08 Exam Preparation Committee. Dr. McPartland has served as a supervisor for student interns through the Minority Science and Engineering Internship Program (MSEIP) and the Research Initiative for Science Education (RISE) Program. Drs. Groziak, Kotchevar and McPartland supervised research students through the CSU-Alliance for Minority Participation (AMP) Program. Dr. Andrews and Dr. LeDuc conducted workshops for K-12 teachers through the East Bay Science Project and Bay Area Science Project.

Student Achievement

During the past five years student achievement among our chemistry and biochemistry undergraduates and Master's students has continued at a high level. Each year several of our students were admitted to Ph.D. programs or professional schools. Five students received Associated Student Fellowship or Scholarship awards for research projects ($1,800 or $1,200 awards). Two students received Schering-Plough research awards to fund laboratory projects. One of our undergraduates earned a $5,000 Genentech Scholar's award and one of our Master's students received the 2006 Crellin Pauling award for excellence in teaching from CSUPERB. Additionally, at least two students were awarded local scholarships each year.

b. Curriculum and Student Learning

Assessment of Program

A copy of the program's outcomes assessment plan can be found in Appendix A. The plan begins with the department mission statement. As indicated in the statement, our primary mission is to provide a strong education in chemistry and biochemistry that prepares students to function and thrive in society. The department currently offers courses for several populations of students. For our chemistry and biochemistry majors, we strive to provide a firm grounding in the important disciplines of chemistry - inorganic, analytical, organic, physical and biochemistry - with the types and numbers of courses in each area geared to the particular major and option. We recognize the importance of emphasizing the use of modern laboratory techniques and instrumentation relevant to chemistry and biochemistry in our curriculum. We also understand the value of research experience in the training of chemists and biochemists. Accordingly, we encourage our advanced undergraduates and Master's students to participate in faculty sponsored research projects or outside internships.

Science students majoring in disciplines such as Biology, Physics, Environmental Science or Engineering often take majors-level chemistry or biochemistry courses in areas relevant to their fields. In all our major courses, we emphasize problem solving and critical thinking skills, and the use of the scientific method in analyzing chemical hypotheses and data. We believe these skills are essential for proper training of competent scientists and responsible members of society. We also encourage students to think critically about the use of chemicals in society and about the responsibility of scientists to contribute to societal issues relating to chemistry and biochemistry.

The first part of our assessment plan outlines the broad objectives for each of our degree programs and how the objectives are measured. The second part of the plan lists specific course objectives and how they are measured for upper division requirements taken by chemistry and biochemistry majors and by students in the Master of Science program.

A summary of the assessment data obtained and an analysis of what has been learned from this information and steps taken are described in the Assessment of Learning Outcomes for Chemistry and Biochemistry Majors document in Appendix B. Although the Program Assessment Plan outlines methods for analyzing a variety of upper division courses, the most consistent data tabulation over the last four years has occurred in the organic chemistry and biochemistry areas. We have emphasized these areas because the physical, analytical, and inorganic chemistry series, (and some of the biochemistry courses), have not been continuously taught by full-time faculty. This has made it difficult to consistently collect assessment data.

Appendix B describes data gathered and analyzed for the organic chemistry lecture and lab series (Chem 3301-02-03), the biochemistry lecture series (Chem 4411-12-13) and an advanced biochemistry lab course (Chem 4431). The data for the organic lecture series is obtained from the standardized American Chemical Society organic exam, which is given as the final exam for the third course in the series. Use of the standardized exam allows us to compare results from one year to the next and to compare our results to the national norms. Data collected over the last four years reveals that our averages have been consistently near the national average. Organic laboratory skills were assessed through a capstone experiment involving identification of two unknown compounds. Results have varied somewhat over the past four years, but the majority of students have been able to identify one of the two unknowns.

Biochemistry learning objectives were assessed by embedded questions in exams given throughout the year-long lecture series. Between 60 and 70 percent of the majors mastered the specific learning objectives, which were scored as correct when 75% of the possible points were assigned. Student learning outcomes for the advanced biochemistry laboratory course were assessed through embedded questions in laboratory quizzes. Marked improvement was seen in the number of students understanding the significance of their experimental results after additional teaching time was devoted to group data analysis.

Assessment of General Education Programs

Each of the three courses in our first year General Chemistry series (Chem 1101-02-03) can be used to satisfy the General Education (GE) Area B Natural Science requirement (B1) and the Area B Natural Sciences Laboratory requirement. Some of the introductory or basic chemistry and biochemistry classes offered by the department as service courses for disciplines such as Biology, Pre-Nursing and Health Science also satisfy the Area B1 and/or the Area B Natural Sciences requirements. We also offer chemistry courses on specific topics designed for non-science majors.

In all our general education offerings we strive to introduce non-science majors to scientific concepts and terminology, the use of the scientific method, and the application of chemical principles to everyday life. In the GE courses with both lecture and laboratory components, we especially emphasize problem solving, hands on experimentation and data analysis. In all our GE courses we attempt to teach not only chemical principles but also to give examples of how scientific knowledge can be used to improve and/or complicate modern society. Our goal is to give non-science majors a positive learning environment in which to gain basic knowledge about chemistry and its role in society. We hope to engage students in a sustained interest in chemistry that can help them become informed citizens.

During the past three years we have collected assessment data for two of our GE courses. A summary of this data is located in Appendix C. The student learning outcomes follow the guidelines as described in the "Final Report General Education Faculty Learning Community 2005-2006". In particular, we assess the students' ability to communicate concepts presented in the course, their ability to use the technical and scientific language learned in the course, whether they can make inferences based upon scientific theories or scientific data, and whether students can determine when statements containing the course material are false. An improvement in students' mastery of these concepts was observed when tutoring was offered for the class and more effort was put into integrating lecture concepts into the laboratory.

Comparison of Degree Programs and Course Offerings to Other Institutions

The Department of Chemistry and Biochemistry offers a BS degree in Chemistry (ACS certified), a BS degree in Biochemistry, a BA in Chemistry, a BA in Biochemistry, a BS in Chemistry with a Forensic Science Option and a Minor in Chemistry. The Department offers the following MS degrees in Chemistry: the Plan A (Thesis), an MS degree in Chemistry with a Biochemistry Option – Plan A (Research Thesis), and an MS degree in Chemistry – Plan B (Comprehensive Review).

Comparisons of these degree programs with those of other CSU institutions and one University of California campus are given in Appendix D. Four California State Universities with similar numbers of undergraduate and MS degrees awarded annually were chosen for comparison with our programs. The University of California, Santa Barbara was also chosen because, unlike many other larger universities, it also awards a

BS Biochemistry degree through the chemistry department. The number of BS and MS degrees awarded by the comparison universities is shown in the table below.

Number of degrees awarded 2005 – 2006[a]

Institution	BS (2005-2006)	MS (2005-2006)
California State University, East Bay	31	10[b]
California State University, Sacramento	25	0
California State University, Northridge	48	8
California State University, Fullerton	36	8
San Jose State University	23	3
University of California, Santa Barbara	144	9

a. Chemical and Engineering News, August 20, 2007, pp 64-73.
b. This number is different from that supplied by the CSUEB Office of Institutional Research and Assessment (see Appendix F).

As can be seen from the tables in Appendix D, our degree programs have requirements similar to those of programs at other universities with corresponding degrees. CSU Sacramento, CSU Fullerton, CSU Northridge, San Jose State, and UC-Santa Barbara all offer BS and BA degrees in Chemistry. CSU Fullerton, CSU Northridge, San Jose State, and UC-Santa Barbara offer BS degrees in Biochemistry. CSU Sacramento offers a BA degree in Chemistry with a concentration in Biochemistry which is comparable to our BA degree in Biochemistry. CSU Sacramento also offers a BA degree in Chemistry with a Concentration in Forensic Science while we offer a BS degree in Chemistry with an Option in Forensic Science (comparison shown in Appendix D). We are the only two Chemistry Departments in the CSU system at this time to have an option or concentration in Forensic Science.

The course requirements for our MS degree programs in chemistry are more variable than those for the BS or BA degrees in order to provide freedom for students to concentrate in the area of greatest interest to them. The number of core and elective course units required varies from 33 to 37, with the remainder of the 45 units coming from completion units such as units for the thesis (Plan A), seminar, or the comprehensive review exam and paper (Plan B). As can be seen from Appendix D, these requirements are typical across all of the CSU comparison institutions. Only UC Santa Barbara requires fewer total units for the MS degree in Chemistry.

A list of our course offerings is provided in Appendix E. In addition to the core courses of General Chemistry, Organic Chemistry, Quantitative Analysis, Physical Chemistry, Inorganic Chemistry, Biochemistry, Instrumental Analysis, and the associated labs, we also offer a variety of major electives and general education and service courses.

The range of electives available for students, depending on their interests, includes courses in Environmental Chemistry, Bioanalytical and Forensic Instrumentation, Advanced Organic Chemistry, Protein Structure, Nucleic Acid Chemistry, Major Organ Biochemisty, and Protein Chemistry Techniques. Through the graduate level Advanced Topics in Organic, Physical, and Biochemistry courses, cutting edge topics such as nanotechnology, combinatorial chemistry, drug design, and proteomics and metabolomics have been offered. Different topics are covered every year to allow students to repeat the same course number but study different subjects. The number and variety of electives and special topics compares well with the offerings of corresponding programs at other universities.

General education offerings include basic chemistry courses such as Introduction to College Chemistry and Basic Chemistry for Health Sciences, as well as special topics courses. Popular Topics in Chemistry, which has covered subjects such as energy, and courses such as Chemistry for Human Nutrition and Introductory Chemistry for Genes and Heredity have been available as general education courses for non-science majors. The Making of Wine is an upper division general education chemistry course that includes both a lecture and lab component. The number and variety of general education courses that the Department offers also compares well with the course offerings of corresponding departments at other institutions.

c. Students, Advising, and Retention

Statistics for the Department of Chemistry and Biochemistry on the number of degrees awarded, number of undergraduate and graduate majors, ethnicity of student majors, number of courses and sections, average sections size, FTES, FTEF, and SFR for undergraduate and graduate courses, and ethnicity of faculty are displayed in the tables of Appendix F. This information was obtained from the Office of Institutional Research and Assessment and provides data on our program for the last five years.

The FTES for the Chemistry and Biochemistry Department has increased every year since 2002, from 175.6 in Fall 2002 to 243 in Fall 2006. This rise can be attributed to the following enrollment increases: 1) majors in our B.S. and B.A. Biochemistry and Chemistry programs, 2) M.S. candidates, 3) Pre-Nursing, Health Science, and Biological Science students taking chemistry courses required for their major, and 4) post-baccalaureate students taking chemistry courses for entrance into professional programs in medicine, pharmacy, dentistry, veterinary medicine, etc. The department also has a strong Minor in Chemistry program with approximately 200 students declared per academic year. Students can now choose environmental chemistry and biochemistry electives in partial fulfillment of the program's requirements.

The number of undergraduates majoring in one of the five degree programs offered by the Department of Chemistry and Biochemistry has risen markedly, from 114 students in Fall 2002 to 136 in Fall 2006, with increases in both the Biochemistry and the Chemistry tracks. These enrollment gains are likely due in part to the continued

popularity of the B.S. Biochemistry program and revisions in the Chemistry and Biochemistry degree programs. As expected, the increased number of majors has resulted in a substantial increase in the number of bachelor's degrees conferred by the department, from 19 in the 2002-2003 academic year to 35 in the 2006-2007 academic year. This increase is due primarily to students graduating with a degree in Biochemistry; the number of biochemistry graduates rose from 11 in 2002-2003 to 27 in 2006-2007. The number of students graduating with a degree in Chemistry has remained fairly constant over the past 5 years, between 8 and 10 students each year. However, based on the number of declared majors, we anticipate that both programs will see increases in the number of degrees conferred in the foreseeable future.

Our graduate program has also seen significant enrollment gains over the last five years, from 21 enrolled students in Fall 2002 to 45 in Fall 2006. Most recently, the number of masters' degrees conferred jumped significantly; 11 students received an M.S. degree during the 2006-2007 academic year, more than double the number awarded any of the previous years.

Our student profile reflects the diversity of the student body at CSUEB. The majority of our undergraduate majors identify as Asian/Pacific, as this population has grown steadily over the past five years (from 43 in 2002 to 76 in 2006). The number of Chemistry & Biochemistry majors self-identifying as Black has also risen over the past five years and has stood at 15 in both 2005 and 2006. The last two years has also seen an increase in the number of Hispanic majors in our program, 15 and 11 in 2005 and 2006 respectively. The number of students self-identifying as White, American Indian, or "other" has varied slightly over the last five years with no obvious trend in either direction. Similarly, our number of international students has varied between six and ten students over the past five years.

The largest ethnic group in our Master's program is Asian/Pacific, representing about one-third of our students. The past year has seen increases in the number of students identifying as White or "other." The number of Black and Hispanic students in our program has remained fairly constant over the past five years, ranging from 0 to 2 for the former and 0 to 4 for the latter with no discernible trend. International student enrollment has varied between three and eight students over the last five years.

Between Fall, 2002 and Fall, 2006 our total tenured/tenure-track faculty count rose from eight to ten, whereas our reliance on part-time lecturers varied slightly between four and six. This left us with a total faculty of 14 as of Fall 2006, the same number as in Fall 2002. The Fall, 2006 tenured/tenure-track faculty was composed of nine White members and one Asian. The faculty was evenly split along gender lines, with five males and five females, due to the hiring of two female faculty members in 2006. In June, 2007 two of the part-time tenured faculty members retired permanently. Both were male physical chemists. We are currently conducting a tenure track search for a physical chemist to replace these faculty. Our current tenured/tenure track faculty consists of seven full-time members and one part-timer.

The total instructional FTEF for Fall 2005 and 2006 was greater than in the previous three years. An encouraging difference between the two years is that tenured/tenure-track faculty constituted a slightly greater percentage of the FTE in 2006 than in 2005. The rising FTEF values correspond with the steadily increasing number of course sections offered, 37 in Fall 2002 compared with 65 in Fall 2006. As the number of course sections offered increased over the five year period, the average section size remained fairly constant, ranging from 26 to 21, with the highest ratio observed in Fall, 2002.

Department SFR has also remained fairly constant over the past five years. The numbers for overall SFR range from a low of 18.6 to a high of 21.2. The SFR values for tenured/tenure-track faculty and lecturers are similar, ranging from 17.0 to 21.3 and 17.5 to 23.1, respectively. As is typical, the SFR values for lower division courses are higher than for upper division courses, with a range of 22.7 to 24.8 for the former and 16.7 to 19.1 for the latter over the past five years. In general, chemistry and biochemistry SFR values are affected by the small class sizes of laboratory sections offered with many of our courses. Equipment limitations and safety requirements keep the lab sections small, typically 18 to 24 students. During the past five years the increases in FTES have required the addition of many lab sections.

Student advising is an important component of the enrollment gains observed in our department. The department has created very clear "road-maps" for each of the degree programs offered at both the undergraduate and graduate level (see Appendix G for examples). A complete set of road maps can be viewed on the Department of Chemistry and Biochemistry web site (http://www.sci.csueastbay.edu/chemistry/). These have been invaluable in helping students in deciphering course requirements and pre-requisites and in long-term planning towards graduation. Last year, our department modified its handling of undergraduate advising. All full-time tenured/tenure-track faculty members now participate in undergraduate advising with assignments based on last name rather than the student's declared program. This delegation of work has been successful, particularly in crunch-times, such as the first two weeks of winter quarter with graduation check deadlines impending. Two other advantages of this system have become apparent as well. Firstly, students considering transferring to CSUEB or changing their major have a clear "go-to person" to discuss this transition, increasing the likeliness that they will do so. Secondly, a student can have the same advisor throughout his or her time in the department, even if a decision to switch degree program is made at some point.

Student advising in the Master's program has become much more formalized and extensive. Entering students now take a placement exam very early after admission to the program and get immediate and individualized advice from the Graduate Coordinator on what courses they should take. Work in supervising Plan B students with the completion of their comprehensive literature review paper is also now delegated over all full-time tenured/tenure-track faculty members rather than one. As such, each student can get more individualized attention and help in completing their papers. Plan A students work with the Graduate Coordinator, but also have the mentorship of their research advisor,

with whom they work closely. This relationship between the research mentor and student is a valuable form of advising for our undergraduates as well, particularly with respect to planning their careers and further education.

Departmental recruiting activities over the past five years fall into the following three categories: participation in CSUEB-sponsored events, visits with community college faculty, and brochures. The department faculty and staff put great efforts in highlighting what the Department of Chemistry & Biochemistry has to offer at CSUEB-sponsored events. At the Annual Discover & Explore Days, the department members set up exhibits and demonstrations and multiple faculty attended. An example of the value of such events is demonstrated by the fact that the four students who attended Discover and Explore Day in 2006 are enrolled in our General Chemistry in Fall 2007 as Chemistry or Biochemistry majors. Although not the primary focus of the Science Festival, the chemistry faculty set up a table with catalogs, department "road-maps", and descriptive brochures about the department and routinely field questions about our degree programs and course offerings there. We also have an attractive table at the Major/Minor Fair and Graduate School Open House. Our department-sponsored and American Chemical Society-affiliated Alchemist Club also hosts an informational table at the Freshman Advising sessions held in the summer. Transfer students, especially those from local community colleges, constitute a significant number of our majors. Over the past five years, our faculty and those from the local community colleges have made a number of mutual visits, strengthening the bond between our schools. Finally, our Graduate Committee has designed a very attractive brochure highlighting our Master's program (Appendix H).

d. Faculty

Dr. Anne Kotchevar joined our department as a new tenure track faculty member in Fall, 2002, after a 2001-02 search. Since Fall of 2002 we have conducted four additional tenure track faculty searches and all have been successful. In 2003, we hired a physical chemist and an organic chemist. In 2006, we completed searches for another physical chemist and a biochemist. We are currently conducting two additional searches, one for a physical chemist, the other for a biochemist to join the faculty in the Fall of 2008. As mentioned above, it has been our goal to maintain a good balance of expertise in the various disciplines of chemistry among our faculty. We have also attempted to hire individuals with research programs attractive to undergraduate and Master's students. We feel fortunate to have added a biophysicist who works on viral RNA, an organic chemist who synthesizes potential anticancer agents, a physical chemist who studies toxic metal accumulation and remediation by plants and a biochemist who does protein structure elucidation. The search requests are located in Appendix I.

e. Resources

The chemistry department makes use of the Information Technology Services (ITS) department for maintenance of faculty and staff computers, the computers in the chemistry computer lab, and the computers used to run chemical instrumentation. The computers in the chemistry computer lab run course specific programs such as Chemdraw, Spartan, Trinity Identification of Organic Compounds and Material Safety Data Sheet (MSDS) ChemWatch. The library staff has assisted us in obtaining resources for the Survey of Chemical Literature course, including training licenses for the database searching programs Web of Science and Chem Abstracts On-line. The Chemistry department also relies on Environmental Health and Safety for hazardous waste collection and disposal.

f. Requirements

Two of the five baccalaureate degrees offered by the department require more than 180 units. These are the B.S. Chemistry with Option in Forensic Science degree and the B.S. Biochemistry program. Both degrees encompass additional disciplines beyond those traditionally required in chemistry programs. The Chemistry with Option in Forensic Science degree requires a total of 187 units. It includes special requirements from Criminal Justice and Biological Science. The B.S. Biochemistry degree program consists of 183 units. It requires biology and biochemistry courses that contribute to the high number of units.

The Criminal Justice requirements for the B.S. Chemistry with Option in Forensic Science degree include courses in basic criminal investigation and evidence evaluation; the Biological Sciences requirements for this program include an advanced DNA analysis course (Biol 4485) and the prerequisites for that course (Biol 1401-02-03 and Biol 3121). Also included in the major is a seminar in Forensic Research. This degree provides not only a solid education in chemistry and chemical instrumentation, which is important for forensic work, but also exposes students to key concepts and techniques in criminal justice and molecular biology. As a result the major requires a large number of units, but we believe this is justified because of the importance of these additional fields to forensic science.

The B.S. Chemistry with Option in Forensic Science degree also requires 3-4 units of electives in chemistry or criminal justice. These are not really essential to the program, but simply add interesting coursework. It might be possible to reduce the required units to 184 by eliminating these elective units. This is considered in the next section of our report.

The B.S. Biochemistry degree program requires a year of introductory biology and seven biochemistry courses, in addition to the chemistry, physics and math courses required in a standard chemistry degree. This program provides a solid grounding in chemistry but also gives students broad exposure to biochemistry. It includes a year long

lecture series in general biochemistry, two biochemistry lab courses and a choice of electives in several specialized areas of biochemistry. Introductory biology is required as a pre-requisite to biochemistry. We believe the large number of units is necessary to provide the theoretical background and laboratory experience to adequately prepare students for a career in biochemistry or a related field.

Appendix A

Program Assessment Plan

Mission Statement

The Department strives to provide a strong education in chemistry and biochemistry that prepares its students to function and thrive in our society. The Department attempts to increase the problem solving and critical thinking skills of all students. Non-science students will learn about the scientific and chemical aspects of everyday life that allow them to understand issues related to the environment, energy production, disease prevention and nutrition. Students of the sciences will learn the fundamentals of chemistry that control the interactions of elements and molecules that form the building blocks in nature. Chemistry majors will receive extensive instruction in predicting chemical reactivity. Building on an understanding of mathematics, physics, and biology, chemistry majors will receive a background in the major disciplines of chemistry including inorganic, analytical, organic, physical and biochemistry. Students will learn the protocols and techniques for working safely with chemicals. All chemistry majors should have the ability to search the chemical and scientific literature. The Department recognizes the importance of the pursuit of new knowledge through research in the development of skilled scientists and productive members of society and encourages its students to participate in research projects and cooperative educational opportunities.

Alignment of Department Goals with University Mission

Our program aims are well aligned with the university mission of providing an academically rich learning experience that prepares students to realize their goals, pursue meaningful work and contribute to their community. We strive to offer a broad range of chemistry and biochemistry courses that cover basic principles but also explore specialized areas and include recent advances. We want our graduates to be prepared to succeed in a variety of career choices, whether it be work in the chemical or pharmaceutical industry or further training in graduate programs in chemistry or biochemistry or in medicine, dentistry or other health professions. We recognize the fast pace of research in chemistry, and especially biochemistry, and try to prepare our students to embrace new concepts and to appreciate advances in experimental methods and instrumentation. In our major-level courses we encourage students to think critically about the use of chemicals in society and about the responsibilities of scientists to contribute to societal issues relating to chemistry and biochemistry. Through our General Education program we attempt to give non-science majors a solid introduction to chemistry and the scientific method, with emphasis on how chemistry is used in modern life. We hope to engage these students in a sustained interest in chemistry that can help them become informed citizens.

Student Learning Outcomes for
BA-Chemistry and BS-Chemistry Degrees

It is imperative that CSUEB chemistry students possess sufficient theoretical and practical training in chemistry and biochemistry so that they will be able to assume the significant technical responsibilities required by the chemical and biotechnology industries that will employ them. It is important that our students are not only trained in chemistry but will become respected scientists and research technicians. In addition, it is important that students planning for entrance into graduate school or pre-professional school are more than adequately prepared for post-baccalaureate training.

General Learning Objectives:

Chemistry students should have:
(1) an understanding of the importance of and reason for course prerequisites.
(2) a solid background in advanced mathematics (calculus), physics, and computers.
(3) a solid background in the various areas of chemistry, including: general chemistry, analytical chemistry, organic chemistry, physical chemistry, and biochemistry.
(4) an ability to think critically and to analyze chemical problems.
(5) an ability to work effectively in a laboratory environment and to use modern chemical/biochemical instrumentation and procedures.
(6) an ability to use computers in experiments, data analysis, and in communication.
(7) an ability to work with people in teams to solve chemical problems.
(8) an ability to communicate effectively, both orally and in writing.
(9) an ability to function effectively in their chosen career.

Learning Outcome No. 1: Chemistry students should have a strong background in lower division advanced mathematics (calculus), physics, and computers.

It is the opinion of the faculty of the Department of Chemistry and Biochemistry that a consistent pattern of excellent grades is the best indicator of mastery of the subjects that provide the foundation for the learning of chemistry. Grades provide an excellent indicator of future mastery of chemical and biochemical information. Students should understand the reason for course prerequisites and need to complete specific courses (and course sequences) in the pattern indicated in the catalog.

Learning Outcome No. 2: Chemistry students should have a solid background in the various areas of chemistry: general chemistry, analytical chemistry, organic chemistry, and physical chemistry.

The faculty of the Department of Chemistry and Biochemistry will utilize embedded exam questions in chemistry lecture and laboratory courses to assess student learning in the above areas of chemistry.

Learning Outcome No. 3: Chemistry students should have a solid background in modern chemistry laboratory methods and procedures.

Chemistry 3303 (Organic Chemistry) will be the capstone course for the BA-Chemistry Degree and Chemistry 4240 (Instrumental Methods of Analysis) will be the capstone course for the BS-Chemistry Degree. The faculty will utilized embedded exam questions to assess student learning. Laboratory reports and/or laboratory notebooks may also be utilized to assess student learning and performance.

Student Learning Outcomes for BA-Biochemistry and BS-Biochemistry Degrees

It is imperative that CSUEB biochemistry students possess sufficient theoretical and practical training in chemistry and biochemistry so that they will be able to assume the significant technical responsibilities required by the chemical and biotechnology industries that will employ them. It is important that our students are not only trained in biochemistry, but will become respected scientists and research technicians. In addition, it is important that students planning for entrance into graduate school or pre-professional school are more than adequately prepared for post-baccalaureate training.

General Learning Objectives:

Biochemistry students should have:
(1) an understanding of the importance of and reason for course prerequisites.
(2) a solid background in advanced mathematics (calculus), statistics, physics, computers, and biology.
(3) a solid background in the various areas of chemistry, including; general chemistry, analytical chemistry, organic chemistry, physical chemistry, and importantly, biochemistry.
(4) an ability to think critically and to analyze chemical problems.
(5) an ability to work effectively in a laboratory environment and to use modern chemical/biochemical instrumentation and procedures.
(6) an ability to use computers in experiments, data analysis, and in communication.
(7) an ability to work with people in teams to solve chemical problems.
(8) an ability to communicate effectively, both orally and in writing.
(9) an ability to function effectively in their chosen career.

Learning Outcome No. 1: Biochemistry students should have a solid background in the various areas of chemistry: general chemistry, analytical chemistry, organic chemistry, and physical chemistry.

The faculty of the Department of Chemistry and Biochemistry will utilize embedded exam questions in chemistry lecture and laboratory courses to assess student learning in the above areas of chemistry.

Learning Outcome No. 2: Biochemistry students should have a solid background in biochemistry.

Specifically, biochemistry students should:

(1) understand the structure and function of the basic molecules found in living cells (eg. amino acids, peptides, proteins, enzymes, carbohydrates, lipids, nucleotides, hormones).
(2) understand cell metabolism and its regulation (eg. glycolysis, gluconeogenesis, Krebs cycle, electron transport/oxidative phosphorylation, lipid metabolism, protein/amino acid metabolism, and nucleotide metabolism).
(3) understand enzyme structure, function, and kinetics.
(4) understand DNA and RNA structure and function, DNA replication, and RNA transcription.
(5) understand protein synthesis.
(6) understand the structure, function, and metabolism of other biological molecules (e.g. hormones, heme, and cofactors).

The biochemistry faculty will utilize embedded exam questions in the General Biochemistry 4411, 4412, 4413 course sequence to assess student learning.

Learning Outcome No. 3: Biochemistry students should have a solid background in modern biochemistry laboratory methods and procedures.

Specifically, biochemistry students should:
(1) understand the basic theoretical and practical issues involved in the analysis of biological molecules, including pipetting, solution preparation, buffer preparation, protein purification, centrifugation, spectrophotometric assays, enzyme assays, chromatographic procedures, electrophoresis, and the analysis and manipulation of DNA and RNA, PCR procedures, and plasmid preparation.
(2) understand scientific literature searching procedures.
(3) understand laboratory notebook and report preparation, data analysis, and the use of computers.
(4) understand the basics of laboratory safety.
(5) understand scientific/academic honesty and ethical issues.

Chemistry 4430 (General Biochemistry Laboratory) and Chemistry 4431 (Advanced Biochemistry Laboratory) will provide students with strong training in the procedures noted above. Chemistry 4430 will be the capstone course for the BA-Chemistry (Option in Biochemistry) Degree, and both Chemistry 4430 and Chemistry 4431 will be capstone courses for the BS-Biochemistry Degree. The biochemistry faculty will utilize embedded exam questions in these courses to assess student learning. In addition, the biochemistry faculty will require an extensive laboratory notebook for each of these two courses. The notebook will detail laboratory procedures, data, data analysis, and conclusions. The laboratory notebook and an evaluation by the instructor of the student's laboratory skills will constitute further assessment of learning.

Student Learning Outcomes for
MS - Chemistry (Plan A)
MS-Chemistry (Option in Biochemistry, Plan A)
MS - Chemistry (Plan B)

It is imperative the CSUEB chemistry students possess sufficient theoretical and practical training in chemistry and biochemistry so that they will be able to assume the significant technical responsibilities required by the chemical and biotechnology industries that will employ them. It is important that our students are not only trained in chemistry (and biochemistry) but will become respected scientists and research technicians. In addition, it is important that students planning for entrance into Ph.D. programs or pre-professional programs are more than adequately prepared for entrance into these programs.

Learning Outcome No. 1: Newly-admitted chemistry graduate students should be prepared and ready to study chemistry at the graduate level.

All newly admitted chemistry graduate students are expected to take a chemistry placement exam within the first quarter of their initial admission into the program. This exam covers general/inorganic chemistry, organic chemistry, physical chemistry, and biochemistry. It is administered on a monthly basis by the Department Graduate Coordinator. Students failing the exam (or a portion of the exam) must complete undergraduate chemistry coursework by enrolling in organic chemistry, physical chemistry, or biochemistry courses (and passing coursework with a grade of B or higher).

Learning Outcome No. 2: Chemistry graduate students should have a solid background in advanced chemistry.
Depending upon the Degree Plan/Option, chemistry graduate students must complete coursework in thermodynamics, the chemical bond, biochemistry, and various advanced topics in chemistry (in organic chemistry, physical chemistry, and/or biochemistry).

For Plan A/Plan B programs, assessment of student learning will be conducted in Chemistry 6521 (The Chemical Bond). Chemistry graduate students completing this course should have a solid understanding of the quantum mechanical description of the atom and of chemical bonding found in molecules. The faculty will utilize embedded exam questions to assess student learning.

For Plan A (Option in Biochemistry), assessment of student learning will be conducted in Chemistry 6430 (Protein Chemistry Techniques). Chemistry graduate students completing this course should have a solid background in the laboratory methods necessary to isolate, purify, and analyze proteins. The faculty will utilize embedded exam questions to assess student learning.

Learning Outcome No. 3: Chemistry graduate students should have significant experience in laboratory research methods. Chemistry graduate students should be able to present complex chemical information via oral and written reports.

All three Chemistry Plans/Options have extremely strong laboratory research course requirements. Therefore, depending on the Plan/Option, chemistry graduate students will have completed several research-based courses, including; Chemistry 6830 (Research, 3-6 units), Chemistry 6850 (Methods of Graduate Research, 3 units), Chemistry 6910 (University Thesis, 3 units), Chemistry 6430 (Protein Chemistry Techniques, 4 units), Chemistry 4700 (Survey of Chemical Literature, 2 units), and Chem 4240 (Instrumental Methods of Analysis, 4 units). In addition, students could complete Chemistry 6900 (Independent Study, 1-3 units), Chemistry 4430 (General Biochemistry Laboratory, 4 units), and Chemistry 4431 (Advanced Biochemistry Laboratory, 2 units).

All chemistry graduate students must complete three separate Chemistry Seminar courses (Chemistry 6820, 1 unit each). Students will be expected to select a topic in chemistry or biochemistry, search the literature, develop an oral presentation (using a computer Powerpoint presentation), and answer questions. The seminar is presented to fellow students and to the faculty. The faculty member coordinating the Chemistry Seminar will evaluate each student seminar with respect to scientific content, oral presentation, proper use of visual-aids, and ability to answer questions about the topic.

Depending on the Plan/Option, all chemistry graduate students must complete coursework requiring written reports. Chemistry 6830, 6850, 6901, and 6910 all require formal written reports. In addition, Chemistry 6430 requires written laboratory reports or a laboratory notebook. The supervising faculty will carefully read, review, and edit student reports and assess writing skill.

Learning Outcome No. 4: Chemistry graduate students should be able to successfully complete a capstone project.

Plan A - University Thesis (Chemistry 6910)
Plan B - Comprehensive Examination (Chemistry 6901)

Plan A chemistry graduate students will be expected to submit a completed, well-written University Thesis. The thesis should conform to Department and University guidelines and should document the research topic, background information, research methods, research data/results, conclusions, and references. The thesis will be carefully reviewed by the supervising faculty adviser and thesis committee members. The signed/dated Signature Page of the final draft of the thesis will be considered as the primary assessment criterion, signifying completion of the capstone project and demonstrating significant learning performance.

Plan B chemistry graduate students will be expected to complete Chemistry 6901 (Comprehensive Examination) as the capstone project for the MS- Chemistry Degree. This includes completion of a literature review paper with extensive literature references, an oral examination covering the review paper, and passing a comprehensive written exam. Faculty committee members will review the paper and will also administer the oral exam. The successful completion of a well-written review paper, passing of the oral exam, and passing the comprehensive written exam will be considered as the primary

assessment criteria, signifying completion of the capstone project and demonstrating significant learning performance.

Specific Learning Outcomes for Chemistry and Biochemistry Courses

The Department of Chemistry and Biochemistry has defined Goals and Objectives for the upper division courses in its Degree Programs:

Chem 3301, 3302, 3303 Organic Chemistry

Students who successfully complete this course should:

1. be able to predict bonding, nomenclature, chemical properties and some physical properties of organic compounds if the molecular structure is known.
2. be able to identify common organic functional groups and show a knowledge of the chemistry and reactivity of each functional group.
3. be able to use the results of the common spectroscopic methods (NMR, IR, UV and mass spectroscopy) to determine the structures of simple organic compounds.
4. know and understand the common reaction mechanisms of organic reactions, and be able to indicate the mechanism and type of intermediate involved in the reactions.
5. be able to safely carry out standard laboratory techniques for the purification of organic compounds, including distillation, recrystallization, gas chromatography, thin layer chromatography, and extraction.
6. be able to measure the infrared spectrum of an unknown solid or liquid and be able to identify the functional groups present.
7. be able to carry out standard functional group transformations of organic compounds, and isolate and characterize the resulting products.

The Outcomes Criteria for objectives 1-4 will be based on the score obtained on the American Chemical Society standardized Organic Chemistry Exam. The exam will be given as the final exam in Chem 3303. A satisfactory criterion will be a class average at the 45^{th} percentile or higher.

The Outcomes Criteria for objectives 5-7 will be based on a capstone assignment for Chem 3303 laboratories. Students will identify two unknown organic compounds, one solid and one liquid. This will require purification by distillation, the knowledge of chemical reactivities and classification tests, the ability to obtain spectroscopic data, especially FT-IR, and the ability to interpret the results. At least one derivative will be required, requiring a chemical transformation and purification and characterization of the product. A satisfactory criterion will be correct identification by 90% of the students.

Chem 3511, 3512, 3513 Physical Chemistry

Students who successfully complete this course should:

1. understand how reaction energies are measured.
2. understand the properties of the gas phase and the relationship to energy.
3. be able to correlate bond energies with macroscopic energy determinations.
4. recognize the driving force for chemical reactions.
5. understand the concept of equilibrium as it is applied to various reactions.
6. be able to explain the origin of quantum theory.
7. be able to describe the nature of the electron in the hydrogen atom.
8. be able to describe the building up of the periodic table by electron configuration.
9. be able to correlate the changes observed in spectroscopic methods in terms of quantum theory.
10. understand the importance of rates of chemical reactions in the overall scheme of chemistry.
11. be able to calculate reaction order from the time dependence on concentration.
12. be able to understand and describe transition state theory.
13. understand the nature of solids in terms of their nature, bonding, and properties.
14. understand how statistics and probability can be used to develop thermodynamic concepts.

The Outcomes Criteria will be based on the answers obtained for specific question on the Physical Chemistry Standardized Exam.

Chem 3531, 3532 Physical Chemistry Laboratory

Students who successfully complete this course should be able to:

1. make solutions, perform spectroscopic measurements, and test physical chemistry principles using various types of laboratory equipment.
2. keep a clear laboratory notebook in which they describe objectives and procedures, and tabulate data.
3. understand the error inherent in measurement, and be able to determine the magnitude of the resulting error in a calculated quantity.
4. plot data to determine trends using linear and non-linear fitting.
5. compare their experimental results with those from the literature.
6. perform computer modeling calculations as simulations to support experimental data.
7. apply chemical principles of thermodynamics, quantum mechanics and kinetics to understand the significance of the experiments done in the laboratory.
8. write laboratory reports in the format of journal articles, including sections describing introduction, experimental, results and discussion, and conclusions.
9. carry out a literature search on a current topic, and present the results to classmates.

The Outcomes Criteria for objectives 1-2 and 6 will be based on evaluation of the laboratory notebook and of activities in the laboratory. These scores are incorporated into the overall laboratory report score. A satisfactory criterion will be a score of 75 % or more on the appropriate portion of the lab report score sheet (see below) for 90% of the students.

The Outcomes Criteria for objectives 3-5 and 7-8 will be based evaluation of laboratory reports. A satisfactory criterion will be an overall score of 75% or above for 90% of the students.

The Outcomes Criteria for objective 9 will be based evaluation of student presentations, scored for quality of literature search, discussion of relevant chemistry, organization, and presentation to the class. A satisfactory criterion will be an overall score of 75% or above for 90% of the students.

California State University, Hayward
Department of Chemistry
Chemistry 3531-3532

Score Sheet for Physical Chemistry Laboratory Report

Laboratory Experiment Name:
Oral or written report:

	Points possible	Points earned (Comments)
Introduction and Experimental Sections	10	
Results:		
Data, Graphs and Calculations	35	
Error propagation	20	
Discussion:		
Precision:	5	
Accuracy: literature values, discussion of errors	10	
Extra merit:		
Lab work / preparation	10	
Organization, presentation	10	
Total	100	

Goals and Objectives for Chem 4161 and 4162 Advanced Inorganic Chemistry

The purpose of this course sequence is to equip students with a working knowledge of the basic concepts and electronic properties of the chemical elements in order to describe and explain the chemical properties and reactivities of the elements in the periodic table. The topics covered are determined by guidelines established by the American Chemical Society and exhibited in the widely used textbooks in U.S. universities. The topics emphasized include:

1. **Atomic structure** - the basis for the periodic arrangement of the elements. Students are expected to learn how to explain the structure of the periodic table and the chemical properties of the elements in terms of the quantum theory of electrons and to use this knowledge to explain and predict chemical and physical properties of the elements. They are also expected to learn how to describe states of atoms in spectroscopic term symbols.

2. **Molecular models** – Students are expected to learn how to predict the formulas and geometries of small molecules and to use mathematical group theory to classify molecular symmetry and understand a molecular orbital description of the molecular electronic states. Student are expected to learn how to use character tables and use symmetry labeling to carry out configuration interactions in creating molecular orbital diagrams of simple molecules.

3. **Chemical reactions** – Students are expected to learn the concepts used in modern chemistry to describe and understand the two important classifications of chemical reactions (1) acid/base and (2) oxidation/reduction. Concepts that should be learned include the important definitions of acids/bases including protonic and nonprotonic and solvent-based definitions.
   Students are also expected to learn how to use emf calculations to predict redox reactions in aqueous solutions.

4. **Coordination Chemistry** – Topics to be learned include nomenclature of coordination complexes, valence bond and ligand field theories of coordination compounds, assignments of ground and excited electronic states of transition metal complexes as well as spectral band assignments, the reaction mechanisms of ligand substitution reactions and the mechanisms of photochemical reactions for transition metal complexes.

5. **Organometallic compounds** - Students are expected to learn the most important types of metal- organic ligand complexes involving pi and sigma metal-carbon coordination bonding.

6. **Chemistry of metal and nonmetal families in the periodic table** – The important small inorganic compounds that are stable in the metal and non-metal families of elements are surveyed in order to gain a wide understanding of the compound types and periodic table trends. Students are expected to be able to explain formulas and properties in terms of the quantum theory of electronic structures learned in the beginning of the course.

The outcomes criteria are based on targeted questions in the mid term exams and on the final exams, as well as on graded homework problem sets designed to measure comprehension of the above learning objectives, and on class participation of the students in group discussion and at the blackboard. A passing grade requires at least a 70 % comprehension estimation of the targeted questions.

Goals and Objectives of Chem 4180 - Advanced Inorganic Chemistry Laboratory

The objective of this laboratory course is to illustrate the chemical principles studied in Chem 4161,and 4162 and to practice using the theoretical tools learned in advanced inorganic chemistry by synthesizing inorganic and organometallic compounds, measuring their chemical and spectroscopic properties, and discussing the results in formal laboratory reports. In the process the students are expected to learn how to synthesize inorganic compounds, learn how to use an array of instruments including the GC Mass Spec, magnetic susceptibility balance, diode array UV and visible spectrophotometer, and FT-IR. In the process they will practice using some of the basic laboratory procedures important to chemical research including refluxing, distillation, digestion, sublimation, filtration, reagent handling, safety procedures, micropipetting, and melting point measuring. They also are expected to learn how to search the chemical literature for ideas and corroboration of their results and explanations. They are also expected to learn how to write up their results as printed reports that include data and graphs in a style and format that would be acceptable to scientific review.

The outcome criteria are based on careful evaluation of laboratory technique, experiment results, and the laboratory reports. The reports will be returned for correction and rewriting if necessary.

Chemistry 4411 - General Biochemistry (4 units)

Students who successfully complete this course should:

1. understand buffer theory and the preparation of laboratory buffers.
2. know the structures and properties of the twenty amino acids.
3. know the unique properties and chemistry of the peptide bond.
4. recognize the common structural motifs found in proteins --including the alpha-helix, the beta-sheet, and other structural features.
5. know the properties of enzymes and the basics of enzyme kinetics--including the Michaelis-Menten equation, Lineweaver-Burke equation and graphs, and the basics of enzyme inhibition.

Chemistry 4412 - General Biochemistry (4 units)

Students who successfully complete this course should:

1. understand the basic principles of bioenergetics --including standard and actual free energy changes and the calculation of these energy changes in biochemical reactions.
2. understand the unique chemistry of Adenosine Triphosphate (ATP) --including standard and actual free energy change values for ATP hydrolysis.
3. know the structure and properties of biologically-important carbohydrates.
4. understand the basic details of the major metabolic pathways found in the cell --including glycolysis, gluconeogenesis, glycogen metabolism, the citric acid cycle, electron transport system, oxidative phosphorylation, and fatty acid oxidation.

Chemistry 4413 -General Biochemistry (4 units)

Students who successfully complete this course should:

1. know the basics of protein and amino acid metabolism -- including amino acid catabolism and anabolism and the urea cycle.
2. know the structure and properties of the purine and pyrimidine nucleotides.
3. know the structural details of the DNA molecule and how it is able to replicate.
4. know the structural details of the RNA molecule and how RNA synthesis and processing occurs in the cell.
5. know how proteins are synthesized in the cell using ribosomes, tRNA, and mRNA.

Chemistry 4430 - General Biochemistry Laboratory, (4 units)

Students who successfully complete this course should:

1. know buffer theory and how to prepare a laboratory buffer.
2. know how to perform protein and enzyme activity assays and how to

calculate results from laboratory-derived data.

3. know how to calculate data commonly found in Protein Purification Tables and how to interpret this information.
4. know how to perform enzyme kinetic data analysis and how to present this data in graphical format.
5. know theory and practical details of chromatographic procedures --including gel filtration chromatography, ion-exchange chromatography, and high performance liquid chromatography (HPLC) .
6. know the theory and practical details of electrophoresis of proteins and DNA.
7. know how to develop a well-written laboratory notebook.

Chemistry 4431- Advanced Biochemistry Laboratory (2 units)

Students who successfully complete this course should:

1. know how to isolate and quantify plasmid DNA.
2. understand the theoretical basis for the Polymerase Chain Reaction (PCR) technique and know the important methodologies for cloning PCR products.
3. amplify various segments of a DNA molecule using PCR.
4. analyze the DNA products of a PCR experiment for size and purity using agarose gel electrophoresis.
5. clone PCR fragments into an expression vector and transform the resulting chimeric DNA into *E. coli* cells.
6. know the theoretical basis for and practical details of performing a Western Blot using SDS-PAGE, electroblotting, and detection with primary antibody and enzyme-conjugated secondary antibody.

Outcomes Criteria for Chemistry 4430 and 4431- Biochemistry Laboratory Courses:

Specific questions will be embedded into regular course exams/quizzes. These questions will be either multiple-choice, short-answer/essay, or problem-solving questions. The specific embedded questions will assess the theoretical/procedural/ analytical Goals and Objectives of each course. Exams completed by Chemistry or Biochemistry majors will be identified and the responses to the embedded questions will be tallied and recorded. A specific objective will be considered to be achieved if 70% of the students correctly answer the embedded question(s) pertinent to that objective.

Chemistry 4440 - Protein Structure (3 units)

Students who successfully complete this course should:

1. know the structures and properties of the twenty amino acids.
2. know the unique chemistry and properties of the peptide bond and understand the other bonding forces holding proteins together.
3. know how the primary, secondary, and tertiary structural features of proteins are determined.
4. know the unique structural details commonly found in proteins --including the alpha-helix, the beta-sheet, the loop-helix-loop motif, the "Greek Key" motif, and the hairpin motif, among others.

5. know and understand the unique folding patterns found in specific classes of proteins -- including alpha-domain folding patterns, beta-sheet folding pattern, and alpha/beta-folding pattern.
6. know how proteins fold into complex 3-D structures.
7. know about the unique 3-D of specific classes of proteins including enzymes, antibodies, virus coat proteins, and DNA-binding proteins.

Chemistry 4450- Nucleic Acid Chemistry (3 units)

Students who successfully complete this course should:

1. understand the various types of sequence elements that make up genes, gene-related sequences, and extragenic elements in prokaryotic and eukaryotic genomes.
2. understand promoter structure and mechanisms for regulating transcription through repressors, activators, general and specific transcription factors, enhancers, silencers, external signaling compounds, and alteration of nucleosome structure.
3. know the basics of gene cloning and have a general knowledge of vectors and library construction.
4. understand DNA sequencing technology, assembly of contiguous sequences and the use of sequence differences among individuals for DNA fingerprinting.
5. be able to navigate the national and international genome databases on the web and use the BLAST program to search for homologues of specific cDNAs.

Chemistry 4460 - Major Organ Biochemistry (3 units)

Students who successfully complete this course should be able to:

1. understand the basic anatomy of the major organs of the body -- including skeletal muscle, heart, brain, liver, adipose tissue, kidney, and bone tissue.
2. understand the unique cell stuctures found in the major organs of the body -- including skeletal muscle, heart, brain, liver, adipose tissue, kidney, and bone tissue.
3. understand the biochemistry unique to the major organs of the body -- including skeletal muscle, heart, brain, liver, adipose tissue, kidney, and bone tissue.

Outcomes Criteria for Chemistry 4411, 4412, 4413, 4440, 4450, and 4460:

Specific questions will be embedded into regular course midterm exams and final exams. These questions will be multiple choice, short answer/essay, or problem solving questions. The specific embedded questions will assess each of the Goals and Objectives enumerated for each course.

Exams completed by Chemistry or Biochemistry majors will be identified and the responses to the embedded questions will be tallied and recorded. A specific objective will be considered to be achieved if 70% of the students correctly answer the embedded questions(s) pertinent to that objective.

Chem 4601, 4602 Environmental Chemistry Lecture and Laboratory

Students who successfully complete this course should be able to:

1. perform environmental analyses using procedures that include making a sample collection plan, collection of samples, making solutions, and using various types of laboratory and field equipment to test environmental samples.
2. keep a clear laboratory notebook in which they describe objectives and procedures, and tabulate data.
3. plot data to determine trends using linear fitting.
4. compare their experimental results with those from the literature.
5. write laboratory reports in the format of journal articles, including sections describing introduction, experimental, results and discussion, and conclusions.
6. perform calculations involving acid-base equilibria, multiple equilibria, reaction enthalpy, free energy, and first order decay.
7. understand how chemical pollutants can have complex effects on the environment.
8. understand the chemistry of water equilibria, ozone depletion, and the greenhouse effect.
9. participate in classroom discussions on environmental cleanup sites, ozone hole formation, and alternative energy.

The Outcomes Criteria for objectives 1-5 will be based on evaluation of the laboratory notebook and of activities in the laboratory, and scoring of written reports. As a capstone project in the second quarter they will perform laboratory research on a topic of their own choosing. This will involve planning, sample collection, sample processing and analysis, evaluation of data in the context of the literature, and presentation of that topic in a poster session. A satisfactory criterion will be a score of 75 % or more on the appropriate portions of the lab report score sheets and poster presentations for 90% of the students.

The Outcomes Criteria for objectives 6-9 will be based on examinations. A satisfactory criterion will be an overall score of 75% or above for 90% of the students. Examinations will include questions based on information students provide in classroom discussions.

Appendix B

Assessment of Learning Outcomes for Chemistry and Biochemistry Majors

A. Outcomes from the Organic Chemistry Lecture/Lab Series as an Indicator of Student Performance

Student Learning Outcomes – Organic Chemistry Lecture

To be able to predict physical properties of organic compounds and common organic reaction mechanisms; to use spectroscopic methods to identify organic structures

Assessment Method and Data

At the end of the year-long organic chemistry series, the students were given the standardized American Chemical Society (ACS) Organic Exam. This test is administered at universities throughout the nation and is considered to be the standard for achievement in organic chemistry. The average scores for our chemistry and biochemistry majors were compared with the national distribution and are reported as national percentiles in Figure 1.

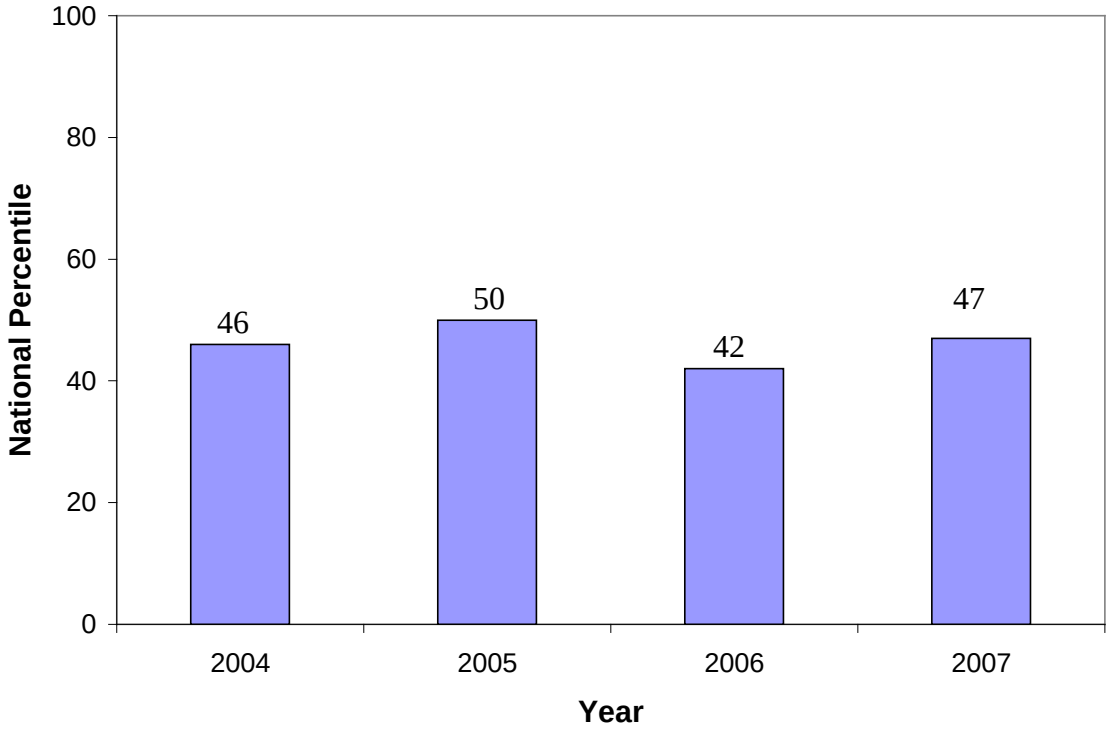


Figure 1. Standardized ACS Organic Chemistry Exam Results for Chemistry and Biochemistry Majors, 2004 – 2007. The number of majors who took the exam ranged from 12 – 22 over the four year period from 2004 through 2007.

Assessment Analysis

Over the last four years the ACS Organic Exam results have consistently been near the nation average (see Figure 1). This is very gratifying and reflects the excellent work of our organic chemistry teaching staff. In 2005 – 2006, the enrollment in the class increased to just under 100 students (many Biological Science majors) and the performance of the majors on the standardized exam dipped slightly. To provide a better learning environment, we decreased the class size to a maximum of 60 by offering two concurrent sections in 2006 – 2007. The impact appears to have been positive with a 5 percentile increase between academic years 2005 – 2006 and 2006 – 2007. Our goal is to maintain this level of performance and break the 50^{th} percentile barrier.

Student Learning Outcomes – Organic Chemistry Lab

To be able to carry out standard organic laboratory techniques, demonstrate knowledge of chemical reactivities, and obtain and interpret spectroscopic data

Assessment Method and Data

A capstone laboratory assignment to be accomplished over several periods served as the performance test. Students were asked to identify two unknown chemicals using various reactions and techniques learned during the year of organic chemistry laboratory. Assessment results are recorded as the percentage of student majors who correctly identified one or both of the chemical unknowns (see Table 1).

Table 1. Results of Capstone Organic Laboratory Assignment for 2004 – 2007

Year	# of Chem/Biochem Majors	# with both correct	% Both Correct	# with at least one correct	% At least one correct
Sp 2004	18	13	72.2	17	94.4
Sp 2005	22	9	40.9	22	100
Sp 2006	22	18	81.8	22	100
Sp 2007	12	5	41.7	10	83.3

Assessment Analysis

From 2004 through 2007, an overwhelming majority of majors were able to identify at least one of the chemical unknowns, although there was a noticeable dip in Spring 2007. In Spring 2004 most students identified both unknowns. In 2005, the experiment was modified slightly to include a more diverse collection of unknown samples. This may be the reason for the observed decrease (from 72% to 41%) in the number of students correctly identifying both unknowns. In 2006, more emphasis was placed on coordinating theoretical principle with practical data analysis. These efforts appeared to be effective as judged by the observation that 81% of the majors were able to

identify both unknowns in 2006. Unfortunately, the 2007 results show a significant drop in the number of students able to identify both unknowns. We are baffled by these results and plan to look closely at next years results to determine if this decrease was an aberration.

B. Student Performance in the Biochemistry Program: Assessment of the General Biochemistry Lecture Series and an Advanced Biochemistry Laboratory Course

Student Learning Outcomes – General Biochemistry Lecture

Learning objectives relating to each major topic in the year-long biochemistry series were outlined. Randomly selected outcomes were assessed for each of the three courses in the series. These outcomes are listed in Table 2, along with the assessment results.

Assessment Method and Data

Specific questions testing the learning outcomes were embedded into course exams in each of the three courses in the series. These took the form of short essay, problem solving or multiple choice questions. The answer was scored as correct when 75% of the possible points were assigned. The assessment results are reported as the percentage of Chemistry and Biochemistry majors correctly answering each embedded question (see Table 2).

Table 2. Assessment Results for Chemistry and Biochemistry Majors in the General Biochemistry Lecture Series, 2006 – 2007.

Learning Outcome	Embedded Question No.	No. of students with correct answer	No. of students with incorrect answer	Percentage of students with correct answer
Know the principles involved in determining the sequence of a protein	1	21	10	68
	2	17	14	55
Understand the basics of enzyme kinetics	1	20	11	65
	2	21	10	68
Know the structure and properties of biologically important carbohydrates	1	25	6	81
	2	25	6	81

Understand the basic details of the major metabolic pathways found in cells	1 2	22 21	9 10	71 68
Know structural details of the nucleic acid molecules DNA and RNA	1 2	24 24	5 5	83 83

Assessment Analysis

Between 60 and 70 percent of the chemistry and biochemistry majors mastered the designated outcomes on average. In some cases the percentage of students able to answer the embedded questions was higher, in other cases lower. We conclude that our majors are doing well, but there is room for improvement. As a general goal, we are aiming for percentages of correct answers above 75% for all the outcomes. Because biochemistry emphasizes the role of chemical principles and reactions in biological processes, it lends itself to problems relating to hypothetical life situations. As an approach to engaging the students more fully and helping them to better learn biochemical principles, we plan to provide more sample situations as practice problems. We hope to use these problems as a starting point for more instructor-student dialogue both in the classroom and through the electronic Blackboard system.

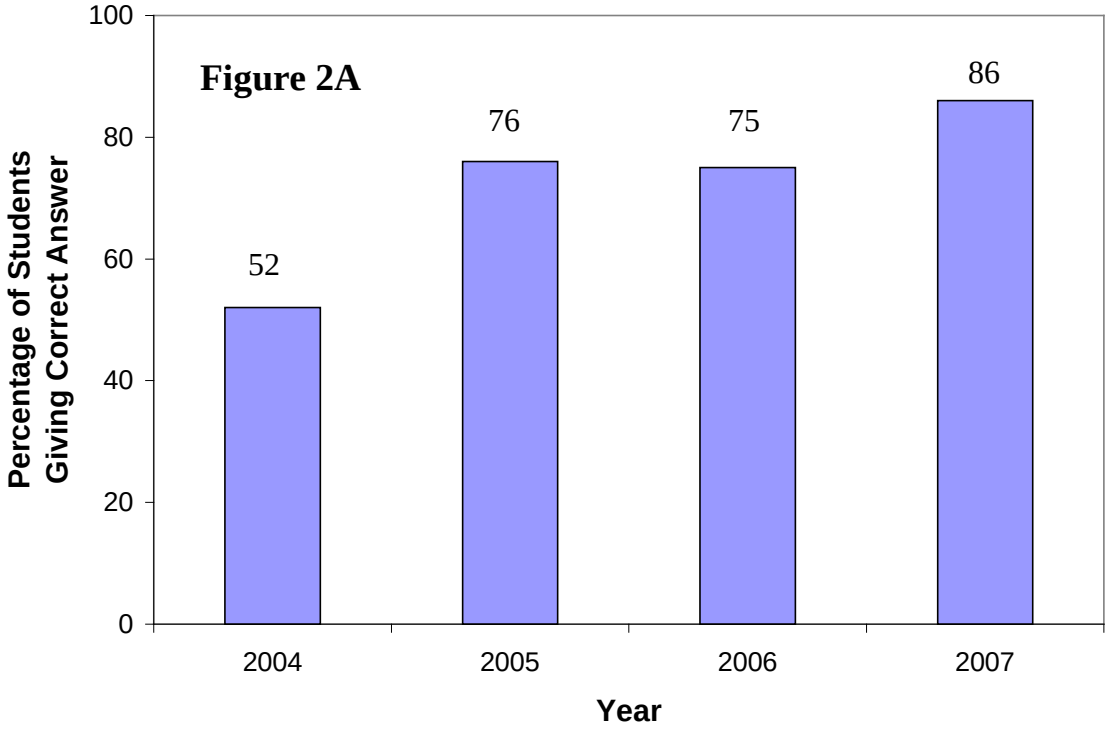
Student Learning Outcomes – Advanced Biochemistry Laboratory

Outcome 1: Understand the theoretical basis for cloning PCR products into a reporter plasmid

Outcome 2: Know the theoretical basis and practical details of performing a "Western Blot" experiment

Assessment Method and Data

Questions relating to the learning outcomes were embedded into laboratory quizzes. These questions were mostly in a short essay format with several parts and were designed to evaluate student understanding of key concepts and techniques covered in the course. The answers were scored as correct when 75% of the possible points were assigned. One multi-part question was used to assess student performance on outcome 1 and two short essay questions were used to assess outcome 2. The results for outcome 2 were averaged. Figures 2A and 2B summarize the results obtained for year 2004 through 2007.



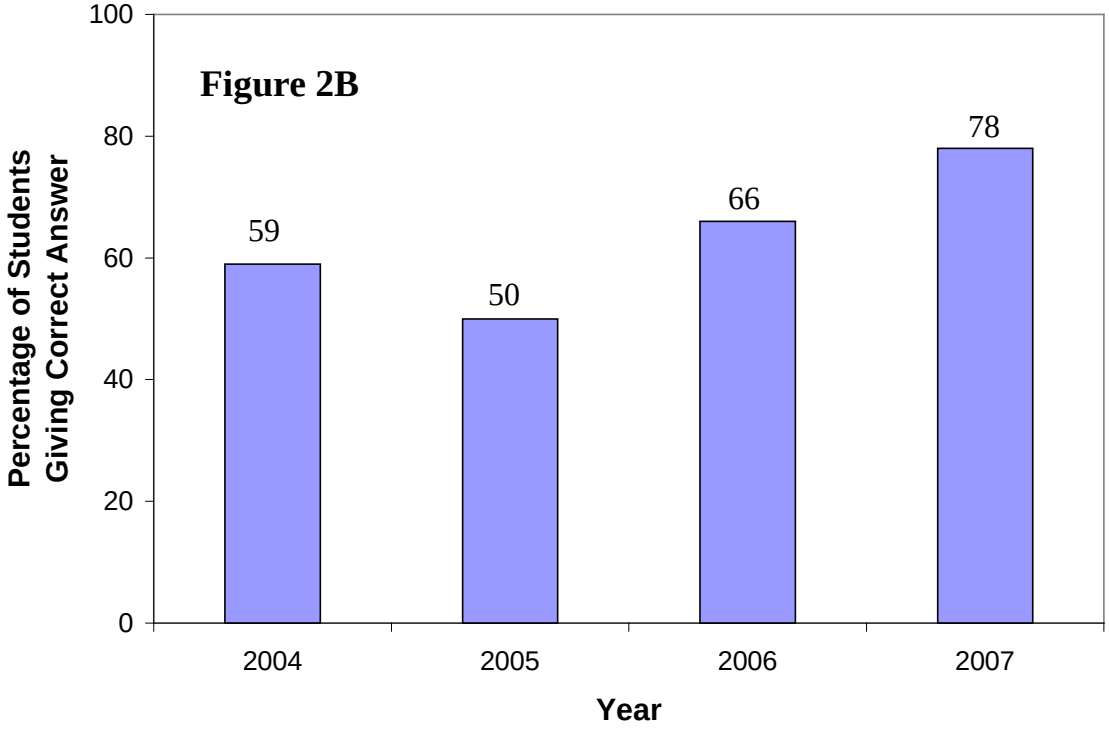


Figure 2. Assessment Results for Chemistry and Biochemistry Majors in the Advanced Biochemistry Laboratory Course, 2004 – 2007. Graph 2A shows the results for outcome 1 and graph 2B gives the data for outcome 2. The number of majors tested varied between 12 and 21 students over the four year period.

Assessment Analysis

The results obtained for embedded quiz questions for year 2004 indicated that nearly half the chemistry and biochemistry majors did not fully understand the significance of the results they obtained in several experiments. In year 2005, more teaching time was devoted to group data analysis. The instructor periodically organized the students into groups for discussion of results and shared data analysis.

The students show a marked improvement in 2005 for outcome 1, but not outcome 2. Because the second outcome, relating to a Western Blot experiment, was covered late in the course, a special effort was made in 2006 and 2007 to discuss this technique with the students in advance of the actual experiment. The students were urged to predict the results of the experiment as a learning methodology. In 2006 and 2007, significantly higher percentages of students mastered both outcomes.

Appendix C

Assessment of General Education Courses Offered by the Chemistry & Biochemistry Department

Student Learning Outcomes for Lower Division General Education Courses
(from GE rubric as described in "Final Report General Education Faculty Learning Community 2005- 2006.")

1. Can communicate three or more key concepts presented in the course.
2. Can use technical and scientific language learned in the course.
3. Can make inferences based upon scientific theories and/or scientific data collected during a class exercise or provided for them.
4. Can determine when statements concerning the course material are false.

Assessment Method

The following two courses were assessed by choosing three questions representative of each of the above indicators in the final examination given in both Fall 2005 and Fall 2006 (for CHEM 1601) and Exam 1 for the Fall 2007 course (for CHEM 1101). Below is a table giving the range of percentages of students scoring exemplary (correct multiple choice question or full credit on a written problem) for the three questions evaluated for each student learning outcome.

CHEM 1601, Basic Chemistry for Health Sciences

Examples of indicators evaluated:

1) Concept of acids and bases, gas laws, and thermodynamic equilibrium
2) Terms in chemical kinetics, thermodynamics, and acid-base chemistry
3) Given rate data, students had to predict the time a reaction would take, determine the pH of a solution, or predict the effect changing a reaction component would have on chemical equilibrium.
4) Evaluated statements regarding reaction catalysts, activation energies, and chemical equilibrium.

	FALL 2005	**FALL 2006**
Outcome 1	24 – 50 %	74 – 81%
Outcome 2	46 – 74%	51 – 81%
Outcome 3	49 – 68%	54 – 80%
Outcome 4	34 – 55%	47 – 69%

Analysis
Improvement was seen on all indicators in Fall 2006, particularly with respect to Indicator 1. The following two changes to the course could explain these findings. Firstly, because of the large size of the course in 2006, it qualified for support by a student assistant. Therefore, additional tutoring hours were offered in 2006 that were not

available in 2005. Secondly, in 2006, the instructor also taught lab sections, which she did not in 2005. Therefore, her student contact was greatly increased, and the laboratory time became a forum where lecture concepts could be incorporated and reinforced.

Conclusions
It is concluded that it is important to continue the support of tutoring for CHEM 1601.

CHEM 1101, General Chemistry

Examples of indicators evaluated:

1) Law of Conservation of Mass, using the Periodic Table to predict ionic charge, and understanding the numerical relationship between protons, neutrons, and electrons for a given element in its ionic and isotopic forms.
2) Identifying examples of chemical and physical change, using systematic names for chemical formulas, and differentiating between ionic and molecular compounds.
3) Determining volume given mass and density, calculating the number of atoms in a given number of grams of an element or compound, calculating the atomic mass of an element given the masses and fractional abundances of its isotopes.
4) Evaluated statements concerning the scientific method and element classification (metal, non-metal, metalloid), and translated a written sentence describing a chemical reaction into a balanced chemical equation.

	EXAM 1
Outcome 1	88 – 94%
Outcome 2	66 – 78%
Outcome 3	71 – 90%
Outcome 4	52 – 89%

Analysis and Conclusions
Data will continue to be collected so that comparisons can be made, conclusions drawn, and improvements made.

Appendix D

BS Chemistry Degree Program Requirements

Course Units	CSU East Bay (quarter)	CSU Sacramento (semester)	CSU Fullerton (semester)	CSU Northridge (semester)	San Jose State (semester)	UC Santa Barbara (quarter)
General Chem	15	10 (15)	10 (15)	10 (15)	10 (15)	15
Calculus	16	12 (18)	16 (24)	16 (24)	10 (15)	20
Physics	15	12 (18)	9 (13.5)	10 (15)	12 (18)	16
Organic	15	12 (18)	10 (15)	13 (19.5)	12 (18)	18
Quant. Anal.	5	4 (6)	4 (6)	4 (6)	4 (6)	3
Physical Chem	9	6 (9)	6 (9)	7 (10.5)	6 (9)	12
Physical Chem Lab	4	6 (9)	3 (4.5)	2 (3)	2 (3)	3
Inorg. Chem	6	3 (4.5)	6 (9)	3 (4.5)	3 (4.5)	6
Inorg. Chem Lab	2	2 (3)	-	1 (1.5)	2 (3)	3
Biochem	4	3 (4.5)	-	4 (6)	4 (6)	3
Instr. Anal.	4	4 (6)	-	4 (6)	4 (6)	3
Computer	4	-	2 (3)	-	3 (4.5)	-
Writing for Chem	-	-	3 (4.5)	-	3 (4.5)	-
Senior Research	-	-	3 (4.5)	1 (1.5)	-	-
Electives	12	11 (16.5)	-	3 (4.5)	10 (15)	11 (16.5)

Note: CSU Sacramento, Fullerton, Northridge, and San Jose State are on the semester system. The equivalent quarter units are shown in parentheses.

BA Chemistry Degree Program Requirements

Course Units	CSU East Bay (quarter)	CSU Sacramento (semester)	CSU Fullerton (semester)	CSU Northridge (semester)	San Jose State (semester)	UC Santa Barbara (quarter)
General Chem	15	10 (15)	10 (15)	10 (15)	10 (15)	15
Calculus	8	12 (18)	8 (12)	6 (9)	4 (6)	12
Physics	12	8 (12)	8 (12)	8 (12)	8 (12)	16
Organic	15	9 (13.5)	10 (15)	8 (12)	12 (18)	18
Quant. Anal.	5	4 (6)	4 (6)	4 (6)	4 (6)	3
Physical Chem	4	6 (9)	6 (9)	3 (9)	4 (6)	12
Physical Chem Lab	-	3 (4.5)	-	1 (1.5)	-	3
Inorg. Chem	-	-	3 (4.5)	3 (4.5)	-	3
Biochem	4	-	3 (4.5)	-	-	-
Bioanal. Instr. Lab	4	-	-	-	-	-
Instr. Anal.	-	-	3 (4.5)	4 (6)	4 (6)	3
Computer	-	4 (6)	2 (3)	-	-	-
Writing for Chem	-	-	3 (4.5)	-	3 (4.5)	-
Chem. Literature	2	-	-	-	-	-
Senior Research	-	-	2 (3)	1 (1.5)	-	-
Electives	11	12 (18)	-	7 (10.5)	19 (28.5)	3 (4.5)

Note: CSU Sacramento, Fullerton, Northridge, and San Jose State are on the semester system. The equivalent quarter units are shown in parentheses.

BS Biochemistry Degree Program Requirements

Course Units	CSU East Bay (quarter)	CSU Fullerton (semester)	CSU Northridge (semester)	San Jose State (semester)	UC Santa Barbara (quarter)
General Chem	15	10 (15)	10 (15)	10 (15)	15
Calculus	12	8 (12)	6 (9)	10 (15)	16
Physics	12	8 (12)	8 (12)	12 (18)	12
Organic	15	8 (12)	8 (12)	12 (18)	18
Quant. Anal.	5	4 (6)	4 (6)	4 (6)	-
Biology	15	10 (15)	8 (12)	12 (18)	11
Stat.	4	-	-	-	-
Physical Chem	9	6 (9)	4 (6)	6 (9)	8
Physical Chem Lab	-	6 (9)	1 (1.5)	-	-
Inorg. Chem	-	-	3 (4.5)	-	3
Biochem	12	6 (9)	8 (12)	11 (16.5)	13
Biochem Lab	6	5 (7.5)	3 (4.5)	5 (7.5)	11
Instr. Anal.	-	-	4 (6)	-	-
Cell Biol	-	-	3 (4.5)	-	-
Computer	4	2 (3)	-	-	-
Writing for Chem	-	3 (4.5)	-	-	-
Senior Research	-	3 (4.5)	-	-	-
Electives	6	-	10 (15)	9 (13.5)	11

Notes: CSU Fullerton, Northridge, and San Jose State are on the semester system. The equivalent quarter units are shown in parentheses.

CSU Sacramento does not have a BS Biochemistry degree program.

BA Biochemistry Degree Program Requirements

Course	CSU East Bay (quarter)	CSU Sacramento (semester)
General Chem	15	10 (15)
Calculus	8	8 (12)
Physics	12	8 (12)
Organic	15	9 (13.5)
Quant. Anal.	-	4 (6)
Biology	15	3 (4.5)
Physical Chem	4	4 (6)
Biochem	12	6 (9)
Biochem Lab	6	6 (9)
Computer	4	-
Electives	6	6 (9)

Notes: CSU Sacramento is on the semester system. The equivalent quarter units are shown in parentheses.

The degree at CSU Sacramento is a BA in chemistry with a concentration in Biochemistry. CSU Fullerton, Northridge, and San Jose State do not have a BA Biochemistry program or BA Chemistry with a biochemistry option or concentration.

BS Chemistry Degree with an Option in Forensic Science Program Requirements

Course	CSU East Bay (quarter)	CSU Sacramento (semester)
General Chem	15	10 (15)
Calculus	12	8 (12)
Physics	12	8 (12)
Organic	15	12 (18)
Quant. Anal.	5	4 (6)
Biology	15	3 (4.5)
Stat.	4	
Physical Chem	6	4 (6)
Biochem	4	6 (9)
Biochem Lab	-	6 (9)
Bioanal. Instr.	4	-
Instr. Anal.	4	
Genetics	5	-
Criminal Invest.	4	3
Comparative Evidence	4	3
DNA Sequencing Anal.	4	-
Forensic Seminar	3	-
Electives	3	6 (9)

Notes: CSU Sacramento is on the semester system. The equivalent quarter units are shown in parentheses.

This degree at CSU Sacramento is a BA in chemistry with a concentration in Forensic Science. CSU Fullerton, Northridge, and San Jose State do not have a BS or BA Chemistry program with a forensic science option or concentration.

MS Chemistry Degree Program Requirements

	CSU East Bay (quarter)	CSU Sacramento (semester)	CSU Fullerton (semester)	CSU Northridge (semester)	San Jose State (semester)	UC Santa Barbara (quarter)
Core or Elective Course Units	33-37	20 (30)	20 (30)	18-24 (27-36)	19 (28.5)	24
Completion Units (Thesis, seminar, exam, etc.)	8-12	10 (15)	10 (15)	6-12 (9-18)	11 (16.5)	12
Total	45	30 (45)	30 (45)	30 (45)	30 (45)	36

Minor in Chemistry Requirements

Course Units	CSU East Bay (quarter)	CSU Sacramento (semester)	CSU Fullerton (semester)	CSU Northridge (semester)	San Jose State (semester)	UC Santa Barbara (quarter)
General Chem	15	10 (15)	10 (15)	10 (15)	10 (15)	15
Organic	15	6 (9)	-	8 (12)	-	-
Quant. Anal.	5	4 (6)	-	4 (6)	-	-
Physical Chem	-	-	-	-	-	4
Physical, Biochem, or Environ Chem	4	-	-	4 (6)	-	-
Upper Div. Electives	-	6 (9)	14 (21)	-	12 (15)	19

Note: CSU Sacramento, Fullerton, Northridge, and San Jose State are on the semester system. The equivalent quarter units are shown in parentheses.

Appendix E

List of Course Offerings at CSUEB

Courses for Majors

1101, 1102, 1103 General Chemistry
2200 Quantitative Analysis
3200 Bioanalytical and Forensic Instrumentation
3301, 3302, 3303 Organic Chemistry
3400 Introductory Biochemistry
3501 Biophysical Chemistry
3511, 3512, 3513 Physical Chemistry
3531, 3532 Physical Chemistry Lab
4161, 4162 Inorganic Chemistry
4180 Inorganic Chemistry Lab
4240 Instrumental Methods of Analysis
4311 Advanced Organic Chemistry
4411, 4412, 4413 General Biochemistry
4430, 4431 Biochemistry Lab
4440 Protein Structure
4450 Nucleic Acid Chemistry
4460 Major Organ Biochemistry
4521 Elements of Chemical Thermodynamics
4601, 4602 Environmental Chemistry
4700 Survey of the Chemical Literature
4830 Seminar in Forensic Chemistry
4810 Undergraduate Research

Graduate Courses

6310 Advanced Topics in Organic Chemistry
6410 Advanced Topics in Biochemistry
6510 Advanced Topics in Physical Chemistry
6430 Protein Chemistry Techniques
6521 The Chemical Bond

Courses for Non-Majors

1000 Popular Topics in Chemistry
1100 Introduction to College Chemistry
1601, 1602 Basic Chemistry for the Health Sciences
2001 Chemistry for Human Nutrition
2002 Introductory Chemistry for Genes and Heredity
2301, 2302 Survey of Organic Chemistry
3010 The Making of Wine

Appendix F

Data in Appendix F was obtained from the Academic Performance Review Statistics available from Institutional Research and Assessment (http://www.csueastbay.edu/ira/).

Number of degrees awarded for the past five years

Degree	**2002-2003**	**2003-2004**	**2004-2005**	**2005-2006**	**2006-2007**
Biochemistry Undergraduate	11	12	21	21	27
Chemistry Undergraduate	8	10	9	8	8
Total Undergraduate	**19**	**22**	**30**	**29**	**35**
Chemistry Graduate	3	4	5	4	11
Total Degrees	**22**	**26**	**35**	**33**	**46**

Number of undergraduate and graduate majors

Degree	**Fall 2002**	**Fall 2003**	**Fall 2004**	**Fall 2005**	**Fall 2006**
Biochemistry Undergraduate	75	79	81	91	90
Chemistry Undergraduate	39	39	37	50	46
Total Undergraduate	**114**	**118**	**118**	**141**	**136**
Chemistry Graduate	21	28	37	36	45
Total Degrees	**135**	**146**	**155**	**177**	**181**

Ethnicity of Chemistry Undergraduate Majors

	Fall 2002	Fall 2003	Fall 2004	Fall 2005	Fall 2006
White	8	10	13	12	11
Black	2	5	6	8	8
Hispanic	1	1	1	3	2
Asian/Pacific	14	16	11	20	20
American Indian	1	2	1	1	-
Other	12	6	7	7	3
International	3	2	2	1	3

Gender of Chemistry Undergraduate Majors

	Fall 2002	Fall 2003	Fall 2004	Fall 2005	Fall 2006
Male	24	17	12	18	19
Female	17	25	29	34	28

Status of Chemistry Undergraduate Majors

	Fall 2002	Fall 2003	Fall 2004	Fall 2005	Fall 2006
Full-Time	28	29	36	40	41
Part-Time	13	13	5	12	6

Ethnicity of Biochemistry Undergraduate Majors

	Fall 2002	Fall 2003	Fall 2004	Fall 2005	Fall 2006
White	19	15	17	16	10
Black	7	8	7	7	7
Hispanic	5	7	7	12	9
Asian/Pacific	29	34	39	48	56
Other	12	13	15	10	13
International	4	8	8	7	3

Gender of Biochemistry Undergraduate Majors

	Fall 2002	Fall 2003	Fall 2004	Fall 2005	Fall 2006
Male	31	35	34	40	43
Female	45	50	59	60	55

Status of Biochemistry Undergraduate Majors

	Fall 2002	Fall 2003	Fall 2004	Fall 2005	Fall 2006
Full-Time	63	73	75	87	79
Part-Time	13	12	18	13	19

Ethnicity of Chemistry Graduate Students

	Fall 2002	Fall 2003	Fall 2004	Fall 2005	Fall 2006
White	-	-	2	5	9
Black	2	2	-	1	2
Hispanic	-	1	4	3	2
Asian/Pacific	6	10	9	9	14
Other	4	3	3	2	9
International	5	3	5	8	4

Gender of Chemistry Graduate Students

	Fall 2002	Fall 2003	Fall 2004	Fall 2005	Fall 2006
Male	7	11	9	11	13
Female	11	8	12	14	23

Status of Chemistry Graduate Students

	Fall 2002	Fall 2003	Fall 2004	Fall 2005	Fall 2006
Full-Time	5	6	11	7	12
Part-Time	13	13	10	18	24

Number of Faculty

	Fall 2002	Fall 2003	Fall 2004	Fall 2005	Fall 2006
Full-Time Tenured/ Tenure-Track	5	7	7	7	7
Part-Time Tenured/ Tenure-Track	3	2	2	2	3
Total Tenured/ Tenure-Track	**8**	**9**	**9**	**9**	**10**
Full-Time Lecturer	0	0	0	0	0
Part-Time Lecturer	6	4	5	6	5
Total Lecturer	**6**	**4**	**5**	**6**	**5**
Total All Faculty	**14**	**13**	**14**	**15**	**14**

Ethnicity of Tenured/Tenure-Track Full- and Part-Time Faculty

	Fall 2002	Fall 2003	Fall 2004	Fall 2005	Fall 2006
White	8	8	8	8	9
Black	-	-	-	-	-
Hispanic	-	-	-	-	-
Asian	-	1	1	1	1
Native American	-	-	-	-	-

Gender of Tenured/Tenure-Track Full- and Part-Time Faculty

	Fall 2002	Fall 2003	Fall 2004	Fall 2005	Fall 2006
Male	5	6	6	6	5
Female	3	3	3	3	5

FTE and FTEF

	Fall 2002	Fall 2003	Fall 2004	Fall 2005	Fall 2006
FTE for Tenured/ Tenure-track	5.2	7.0	7.0	7.6	8.5
FTE for Lecturers	3.1	2.5	3.9	4.7	3.7
Total Instructional FTEF	8.3	9.5	10.9	12.3	12.2

FTES

	Fall 2002	Fall 2003	Fall 2004	Fall 2005	Fall 2006
FTES	176	195	226	229	243

Student Faculty Ratios (SFR)

	Fall 2002	Fall 2003	Fall 2004	Fall 2005	Fall 2006
Number of Course Sections Offered	37	48	56	60	65
Average Sections Size	26	23	22	22	21
SFR (all courses, all faculty)	21.2	20.5	20.7	18.6	20.1
SFR Tenured/ Tenure-Track	20.4	21.3	19.4	17.0	21.2
SFR Lecturers	22.5	18.1	23.1	21.3	17.5
SFR for Lower Division	23.7	24.8	22.7	22.7	23.9
SFR for Upper Division	17.8	18.9	16.9	16.7	19.1

Appendix G

M.S. Program in Chemistry: Plan A

	FALL	WINTER	SPRING
First Year	CHEM 4521 Elem Chem Thermo (4)[a,b] CHEM 6310 Adv Topics Org Chem (3)[c,g] CHEM 6820 Seminar (Audit)[e] Must satisfy Writing Skills requirement by examination or coursework Must take Placement Exams before classes begin and take remedial classes if necessary**	CHEM 6510 Adv Topics Phys Chem (3)[b,g] CHEM 6820 Seminar (1)[e] Elective* and/or Research[g]	CHEM 4700 Survey Chem Literature (2)[d] CHEM 6521 The Chemical Bond (3)[b] CHEM 6820 Seminar (1)[e] Elective*, Advanced Topics[g] or Research[h,i]
Second Year	CHEM 6830 Research(1)[h,i] CHEM 6820 Seminar (1)[e] Elective*, Advanced Topics[g]	CHEM 6850 Meth Grad Research (3)[f,i] CHEM 6820 Seminar (AU)[e] Elective*, Advanced Topics[g] or Research[h,i]	CHEM 6910 Thesis (3)[f,i] CHEM 6820 Seminar (AU)[e] Elective*, Advanced Topics[g] or Research[h,i]

***Electives (to 45 units. At least 23 units for the M.S. degree must be 6000-level) Electives must be approved by your advisor:** CHEM 4411 (3), CHEM 4412 (3), CHEM 4413 (3), CHEM 4430 (3), CHEM 4440 (4), CHEM 4431 (4), CHEM 4450 (3), CHEM 4460 (3), CHEM 3531 (2), CHEM 3532 (2), CHEM 4161 (3), CHEM 4162 (3), CHEM 4311 (3), CHEM 3531 (4), CHEM 3531 (4), CHEM 6430 (4), BIOL 6140 (4), BIOL 4450 (4), BIOL 6151 (5), BIOL 6152 (5), CHEM 4240 (4), CHEM 6410 (3).

[a]Offered every other Fall.
[b]Requires passing grade on Physical Chem placement exam or completion of Chem 3511-2-3 with a grade of B or better.
[c]Requires passing grade on Organic Chem placement exam or completion of Chem 3301-2-3 with a grade of B or better.
[d]Strongly advised for all MS Chemistry students.
[e]First time students should audit this course. Students should attend seminar all quarters of the MS program, 3 quarters for credit.
[f]Taken in last quarter or the quarter preceding graduation.
[g]May be repeated for credit. A total of 9 units of Advanced Topics classes are required for Plan A.
[h]Up to 9 units of CHEM 6830 and 4 units of CHEM 6900 may be taken.
[i]These must be arranged well in advance with an instructor and may occasionally be available in Summer quarters.
**Remedial classes will not count towards the MS degree.

B.S. Program in Chemistry

	FALL	WINTER	SPRING
First Year	CHEM 1101 General Chemistry I (5)* MATH 1304 Calculus I (4) GE	CHEM 1102 General Chemistry II (5) MATH 1305 Calculus II (4) GE	CHEM 1103 General Chemistry III (5) MATH 2304 Calculus III (4) GE
Second Year	CHEM 2200 Quantitative Analysis (5)** CHEM 3301 Organic Chemistry I (5)* PHYS 1001 General Physics I (5) GE	CHEM 3302 Organic Chemistry II (5) PHYS 1002 General Physics II (5) CS 1020 Introduction to Computers or CS 1160 Introduction to Computer Science and Programming Methods (4) GE	CHEM 3303 Organic Chemistry III (5) PHYS 1003 General Physics III (5) MATH 2101 Elements of Linear Algebra (4) GE

GE – General Elective

ME – Major Elective

Chemistry Electives (3- 4 courses, 11-12 units): CHEM 4311 (4), CHEM 4412 (4), CHEM 4430 (4), CHEM 4521(4), CHEM 4601(4), CHEM 4602 (4), CHEM 4810 (2), CHEM 4413 (4), CHEM 4700 (2), CHEM 4900 (1-4). (No more than four units of CHEM 4810 and CHEM 4900 combined may be applied to the major).

*Sequence may be taken W, Sp, Su
**Offered during summer quarter

Appendix H

Required Coursework

Plan A (Research-based Thesis)
Complete 22 units in required courses, including Chem 4521, 6521, 6820, 6830, 6850, and 6910. Complete ≥ 9 units in Advanced Topics courses (Chem 6310, 6510). Complete a total of ≥ 45 units of additional, approved courses. Submit an acceptable University Thesis.

Plan B (Comprehensive Exam)
Complete 21 units in required courses, including Chem 4240, 4521, 4700, 6521, 6820, 6850, and 6901. Complete ≥ 12 units in Advanced Topics courses (Chem 6310, 6510). Complete a total of ≥ 45 units of additional, approved courses. Pass a written Comprehensive Exam on coursework, and write and orally defend a significant Literature Review paper on an approved topic.

Biochemistry Option (Research-based Thesis)
Complete 22 units in required courses, including Chem 6410, 6430, 6820, 6830, 6850, and 6910. Complete ≥ 6 units in Chem 4521, 6110, 6310, 6521, and at least one of 4521 or 6521. Complete a total of ≥ 45 units of additional, approved courses. Submit an acceptable University Thesis.

Research

Almost all of our Plan A students conduct research in on-site labs *(like that shown below)*, directed by one of the Department's research-active Faculty members. Candidates whose employers permit the use of their own facilities and approve the release of research findings *may* arrange to conduct research on their employer's premises, subject to prior approval by the Department.

For Further Information

The M.S. Chemistry program is run by a Graduate Coordinator, Prof. Joy Andrews (joy.andrews@csueastbay.edu), who is assisted by the Department's Chair, Prof. Ann McPartland (ann.mcpartland@csueastbay.edu), and a Graduate Studies Committee of Faculty members.

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Fax: (510) 885-4675

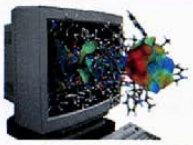
http://www.sci.csueastbay.edu/chemistry/

The Master of Science Degree in Chemistry at CSU East Bay

Chemistry and Biochemistry Department Office:
Science North, Room 431

You will benefit from earning an M.S. degree in Chemistry *if*:

1. You are seeking a job in industry *beyond* the B.S. degree level, *or*
2. You are now employed at the B.S. degree level, but want to *advance* your career, *or*
3. You want to *teach* high school or community college level Chemistry or Biochemistry, *or*
4. You want to pursue a *Ph.D. degree* in Chemistry *or* Biochemistry in the future, *or*
5. You want to *strengthen* your application to Medical, Dental, or Pharmacy School.



Faculty

The Professors in the Chem and Biochem Dept. all hold Ph.D. degrees from highly respected Universities. They bring many experiences to the Program, and provide students with the knowledge and skills they will need to succeed.

Dr. Vince Alvarez (Ph.D., UC-Santa Barbara)
Dr. Joy Andrews (Ph.D., UC-Berkeley)
Dr. Kevin Cadogan (Ph.D., Cornell Univ.)
Dr. Michael Groziak (Ph.D., Northwestern Univ.)
Dr. Chul-Hyun Kim (Ph.D., UC-Berkeley)
Dr. Anne Kotchevar (Ph.D., Univ. of Minnesota)
Dr. Danika LeDuc (Ph.D., UC-Berkeley)
Dr. Richard Lulbrand (Ph.D., Univ. of Wisconsin)
Dr. Ann McPartland (Ph.D., Purdue Univ.)
Dr. Richard Monson (Ph.D., UC-Berkeley)
Dr. Charles Perrino (Ph.D., Arizona State Univ.)
Dr. Monika Sommerhalter (Ph.D., Technische Universität Berlin)

Staff

Staff in the Office and Stockroom *(shown below)* and Lecturers are all highly trained and skilled at caring for students' needs.

Audrey Azevedo (Stock Clerk)
Earl Harris (Laboratory Support Technician)
Ron Hicks (Lecturer)
Sandi Jones (Administrative Support Assistant)
Mark Karplus (Lecturer)
Yagaya Kumar (Stock Clerk)
Jim Stanford (Stockroom Manager)
Linda Steele (Administrative Support Coordinator)
Leanne Thompson (Laboratory Support Technician)

Instruments and Facilities

Varian 500 MHz NMR Spectrometer *(shown below)*
With an Indirect Detect probe for ^{1}H, ^{19}F, ^{13}C, and ^{31}P, and a Dual Broadband probe for ^{19}F, ^{13}C, ^{31}P, ^{15}N, ^{11}B, et al.

Perkin Elmer Aanalyst 300 AA spectrophotometer
With flame, graphite furnace and cold vapor capability for detection of metals, useful mainly in environmental analysis.

Hewlett Packard HP1100 and HP1050 HPLCs
For identifying organic and biochemical compounds.

Varian Saturn 2000 capillary GC/MS
For separation and identification of volatile organics.

Varian GC with FID, ECD detectors
To detect organics such as pesticides and flame retardants.

Genesys2 UV/visible spectrophotometer
With a cooling bath, for monitoring biochemical reactions.

Dionex DX500 ion chromatograph (IC)
Capable of analyzing anions, cations, and transition metals in environmental and other samples.

Nicolet 5PC FTIR spectrophotometer
For identifying functional groups in organic compounds.

Hewlett Packard HG8452 UV, infrared and visible (diode array) spectrophotometer

Oxford LabX 3000 X-ray Fluorescence (XRF) Analyzer

Computer Lab *(shown at the right)*
With 24 PCs running Windows XP, loaded with software like Microsoft Office, Internet Explorer, ChemDraw, Chem3D, Spartan '02 and'04, and Identification of Organic Compounds.

Admission Requirements

Applicants need a Bachelor's degree equivalent to one in our Department and a GPA of ≥ 2.6 in upper division Chem/Biochem courses. GRE scores are not required.

Placement Exams are used to determine if there are any deficiencies to be made up. An Undergraduate degree *outside* of Chemistry may *still* be used, but you may be required to take additional classes as an unclassified postbaccalaureate student before entering the M.S. Chemistry Program.

Students are first "Conditionally Classified" Graduate Students. After taking Placement Exams, making up any deficiencies, completing 12 units applicable to the M.S. degree, and passing the University's Writing Skills Test, they become "Classified" Graduate Students.

Plan Options

Plan A (Research-based Thesis)
This involves conducting laboratory research (usually on-site) and requires the writing of a University Thesis.

Plan B (Comprehensive Exam)
No research, but this requires (1) taking extra courses, (2) passing a written Comprehensive Exam on coursework applied to the degree, and (3) writing a significant *literature review* paper on an approved topic, and defending it orally before a Faculty Committee.

Biochemistry Option (Research-based Thesis)
Plan A, but with a focus in the Biochemical Sciences. (A Biochemistry-focused Plan B is available too.)

Appendix I

Memorandum

Department of Chemistry and Biochemistry

Date: May 1, 2007

To: Michael Leung, Dean, College of Science

From: Ann McPartland, Chairperson, Chemistry and Biochemistry

Subject: Request for Tenure Track Faculty Positions in Biochemistry and Physical or Analytical Chemistry

The Department of Chemistry and Biochemistry requests authorization to hire two tenure track faculty members during the 2007-08 academic year. The individual sought for the first position would hold a Ph.D. in biochemistry or a related field. The second request is for a Ph.D. chemist to teach in the areas of physical, inorganic and analytical chemistry. Various areas of specialization would be considered for this position.

The acute need for two new tenure track positions is due to the unexpected death of one of our biochemistry faculty members in 2006 and the imminent departures of two faculty who are completing five years in the Faculty Early Retirement Program (FERP) this year. These losses mean the projected percentage of chemistry and biochemistry courses that can be taught by tenure track faculty in 2007-2008 is only 53%, well below the CSU system wide target percentage of 75%.

Enrollment and FTE figures for the last four years clearly show a growth trend for the department. Between Fall, 2002 and Fall, 2006 the number of Chemistry and Biochemistry majors rose 19 %, from 114 to 136. The Master's degree program also grew. Between Fall, 2002 and Fall, 2006 the number of Master's degree candidates doubled, from 18 to 36 students. During this same period, the Chemistry and Biochemistry department annualized FTES values rose 37 %, from 177 in 2002 to 242 for 2006. Undergraduate degree output increased 53%, from 19 in 2002-03 to 29 in 2005-06. The Chemistry Minor program remained strong, with 197 students declared for SFWSp 2004-05 (latest figures available), the fourth highest number for all Minor programs at CSUEB.

Justification for the Requested Biochemistry Position: Our biochemistry program is strong and growing. The B.S. Biochemistry degree program, established in 1998, has grown at a rapid pace. We now have about 90 majors. A new B.A. Biochemistry degree program was recently approved and initiated in Fall, 2006. We anticipate new majors

entering this program. Recently the Biological Sciences Department introduced a Cell and Molecular Biology option under their B.S. degree program. In this option the students take more biochemistry than previously required for the B.S. Biological Sciences degree. This change has impacted our biochemistry courses and we have had to open new sections to accommodate the Biological Sciences majors.

Because of the unexpected death of one of our biochemists and retirements, 47 % of our courses will need to be covered by lecturers in 2007-2008. In the biochemistry area, this translates to seven 3000 and 4000 level courses. During 2006-07 we had to hire five different part time lecturers to cover seven upper division biochemistry courses, some of them quite specialized. All of these courses had robust enrollments, but this situation has not served our students well. The instructors are all inexperienced and all are working at full time jobs elsewhere. It is not appropriate to have so many of our major courses taught by temporary faculty. Moreover, we have not added sections that would likely be taken by some of our Master's degree students because of lack of instructors.

We currently have only two tenure track biochemists in the department and one of these is chairperson. This is simply not adequate faculty to serve the students in our growing biochemistry degree programs and to provide quality instructors for our service courses in biochemistry. Our deceased biochemist, Dr. Larry Scheve, was the driving force behind the progress we have made in the biochemistry program. A new tenure track biochemist is desperately needed to maintain the quality of our program and to provide knowledgeable direction for it.

Justification for the Requested Physical / Analytical / Inorganic Chemistry Position:

The department offers three undergraduate degree options in Chemistry: a B.S. degree accredited by the American Chemical Society, a B.A. program and a B.S. degree, option in Forensic Science. As mentioned above, the department maintains a strong Minor program and offers three M.S. degree options. Many of our courses are taken both by chemistry and biochemistry majors, and by students in other degree programs such as Biological Science, Earth and Environmental Science and Engineering. We also offer service courses for Pre-Nursing, Health Science and Biological Science. A significant number of post-baccalaureate students take our courses, often as preparation for a second degree and/or a career in medicine, dentistry, pharmacy or optometry. Additionally, some students take chemistry courses as preparation for the Biotechnology Program or for graduate programs in Chemistry or Biological Science.

Excluding the biochemistry courses and the summer offerings (which are usually taught by lecturers), the courses that will need to be taught by part time lecturers in 2007-08 include three lower division chemistry lecture courses required for the major, one upper division physical chemistry lecture, ten lower division service lecture courses, two graduate lecture courses in physical chemistry and many undergraduate laboratory sections. Given the specialized nature of many of the courses in the undergraduate and graduate degree programs in chemistry, the growth of our major and minor programs, and the number of students in other degree programs taking our courses, we desperately need

to replace the two FERPers who are departing this year. We cannot continue to provide quality courses in specialized fields if we have to rely on temporary part time faculty. A new tenure track faculty member with expertise in physical, analytical or inorganic chemistry is needed to provide excellence in teaching, and also to maintain a quality graduate program, with ongoing research projects to offer Master's degree students. Moreover, a stable and well trained faculty will make it possible to keep our program current in a rapidly advancing field where knowledge of modern instrumentation has become a must for Chemistry majors.

Memorandum

Department of Chemistry and Biochemistry

Date: April 20, 2005
To: Michael Leung, College of Science Dean
From: Rich Luibrand, Chemistry and Biochemistry Chair
Subject: Request for a Tenure Track Position

The Department of Chemistry and Biochemistry requests authorization to hire a tenure track faculty member during the 2005-2006 academic year. Inspection of enrollment and FTE figures for the last four years clearly shows a growth trend for the Department. Comparing the Enrollment by Major figures, the number of majors has increased by 35% from the Fall Quarter of 2001 to the Fall Quarter of 2004. Corresponding FTE figures show that Chemistry and Biochemistry students were taking 28% more units in Fall 2004 than in Fall 2001. Increase enrollment, coupled with data that shows that only 66% of positions are tenure track provide a compelling argument for the new hire. This corresponds to 1.01 position short of the number required for the current target of 75% tenure track.

The most recent data (2003) from Chemistry Departments in the CSU system reveals:

- **CSUEB Chemistry Degree Productivity (Degree Output/FTEF) is the highest in the system for total number of degrees, and for baccalaureate degrees, and is second (to CSU Fullerton) in M.S. degrees.** The total number of baccalaureate degrees awarded by CSUEB Chemistry and Biochemistry in 2003 is nineteen; three M.S. degrees were awarded in that year.
- **The workload of CSUEB Chemistry faculty is 28% higher than the CSU average** (CSUEB SFR 20.4 vs. CSU Chemistry Average SFR 16.0).

Unlike other departments in the College of Science where lecturers have a high SFR, in the Chemistry and Biochemistry Department the tenure track faculty members carry the greatest teaching burden. In Fall Quarter 2004 the Tenure Track SFR (21.3) was 15% higher than the Lecturer SFR (18.5). In the previous year the Tenure Track SFR (21.8) was 64% higher than the Lecturer SFR (13.3).

In the last two years faculty members from the Chemistry and Biochemistry Department have been awarded almost one million dollars for equipment (NMR) and research.

Two Department faculty members are approaching the time when they can no longer participate in FERP. When this occurs we will have no Tenure Track faculty teaching General Chemistry, a course that has grown to a size that allows offering three lecture sections per year. We should put our best teachers (Tenure Track) in freshman classes where student dependence on teaching is the greatest.

In spite of the rapid growth in the Chemistry and Biochemistry Department, no new hires have been allocated in the last two years. The Department has been unable to fulfill the

requirement of the American Chemical Society that permanent faculty teach the courses required for the degree program that it approves. The department desperately needs a new tenure track faculty member.

Memorandum
Department of Chemistry and Biochemistry

Date: March 25, 2002

To: Michael Leung, Dean, School of Science

From: Rich Luibrand, Chair, Chemistry and Biochemistry

Subject: Request for Tenure Track Faculty Position

The Department of Chemistry and Biochemistry requests authorization to hire a tenure track faculty member during the 2002-2003 academic year. The request is for an Organic Chemist whose specialty is Bio-organic Chemistry. The new faculty member should have a strong desire to teach a broad range of courses, including Chemistry for General Education students, General Chemistry, Organic Chemistry, Advanced Organic Chemistry, and Advanced Topics in Organic Chemistry. The Department has the need for a research specialist with projects that will be attractive to students of organic and biochemistry.

Enrollment Growth

In the last five years for which statistics are available for the performance of chemistry departments in the entire CSU system (1996-2000), enrollments in all chemistry departments declined by twelve percent. During these same years, enrollment at CSU Hayward increased by thirteen percent (https://secure.calstatela.edu/as/co/adr8.chem.htm). The Department is proud of this accomplishment. This growth has been achieved by serving our General Education students, and by introducing an extremely successful new major, the B.S. Biochemistry Degree. For the most recent five-year period (1997-2001) the number of majors has increased by twelve percent. In light of the importance of biotechnology to the economy of the Bay Area, we anticipate continued interest in the study of chemistry and biochemistry.

University's Goals and Objectives

1. Optimize student recruitment and retention

As the Department builds expertise in new areas of research, it will be possible to attract more students into the graduate program.

2. Promote instructional and research excellence

A major objective is the replacement of all separated regular faculty, including participants in the FERP, at a minimum 1:1 ratio in order to increase significantly the proportion of teaching by tenure-track faculty. In 1997 the Department had ten tenure track faculty. As anticipated by previous planning documents, there has been a swarm of retirements. In the Fall of 2002 there will be only five tenure track faculty, representing a fifty percent decline. Three of the five Organic Chemists that were on the faculty in 1997 have now retired and are no longer teaching in the major. One is the last year of his eligibility in the FERP program in 2002-3. One is serving in the role of Department Chair with severely restricted opportunities for teaching. The new Organic Chemist that was hired in 2001-2 has resigned for personal reasons. We are desperate to rebuild an infrastructure of expertise in teaching and research.

During the same five-year period (1997-2001) the total FTEF has decreased by 19 percent, resulting in a thirty percent increase (from 13.65 to 17.80) in total SFR for the period. The corresponding SFR increase for full time faculty (from 12.62 to 18.23) reflects a forty four percent increase in workload during this time, not counting the increase in committee work. The Department SFR is higher than the System SFR, even though a chemistry program is more "labor intensive" due to the need to

- staff low enrollment laboratory classes
- maintain a quality but relatively low enrolled graduate program
- maintain low enrolled senior level courses required for ACS certification
- sponsor undergraduate research.

Directing undergraduate research in an experimental science such as chemistry and biochemistry requires a very large time commitment from faculty, although it does little to increase SFR. Faculty must train students in experimental techniques and constantly supervise them in potentially hazardous laboratory situations.

Reliance on regular faculty

Undergraduate research is an essential part of any good program in chemistry and must be nurtured. The American Chemical Society requires undergraduate research for purposes of accreditation. Also, employers prefer to hire graduates with independent research experience; the decision to continue an education at the PhD level is strongly tied to participation in meaningful undergraduate research activity. Part time faculty cannot be relied upon to supervise undergraduate research. The decrease in tenure track faculty members threatens the Department's ACS accreditation by depriving students of the opportunity for research.

The American Chemical Society requires that courses for the certified degree program should be taught by regular full time faculty. The Department requires an

Organic Chemist to teach upper division courses in organic chemistry. Without a new Organic Chemist the Department is in danger of losing its accreditation.

Balance profession preparation with academic education

An important goal for all of the courses offered by the Department is to increase the abilities of our students in critical thinking and problem solving skills. It is likely that the Organic Chemist that we hire will teach Introductory Chemistry, Chemistry for General Education students, and General Chemistry, in addition to the upper division and Graduate classes. Because chemistry is the "central science" these courses represent a required component for many degree programs such as Biology, Physics, Geology, and the Minor in Chemistry.

Meeting the needs of general education

The Department of Chemistry and Biochemistry has the goal of teaching all of its General Education courses with regular faculty, rather than part time lecturers. This appointment will help us to meet that goal.

Balance "high growth" with "prestige" programs

The B. S. Degree in Chemistry is a program that is accredited by the American Chemical Society. The rapid shrinking of our regular faculty has placed that certification in jeopardy, since the required courses should be taught by tenure-track faculty. We can no longer meet this obligation and are at risk of losing this prestigious degree.

Seeking to meet the demands of future students

The application of organic chemistry to biological systems represents one of the important new directions of modern chemistry. This area has been requested because of the likelihood that students with this training will be especially valued when they seek employment.

Quality department and school plans to absorb and use new faculty

The skills of this new hire will be in demand by both our Department and other units in the School of Science. It is likely that the new hire will eventually become the instructor and coordinator of the Organic Chemistry program that is a requirement in several other departments. We need to have our finest teachers in this program, since these freshman and sophomore students are precisely those who have not yet mastered

the skills of learning independently, and are especially dependent upon good teaching. The new faculty member will be assigned a faculty mentor, and will be assigned research space appropriate for their research.

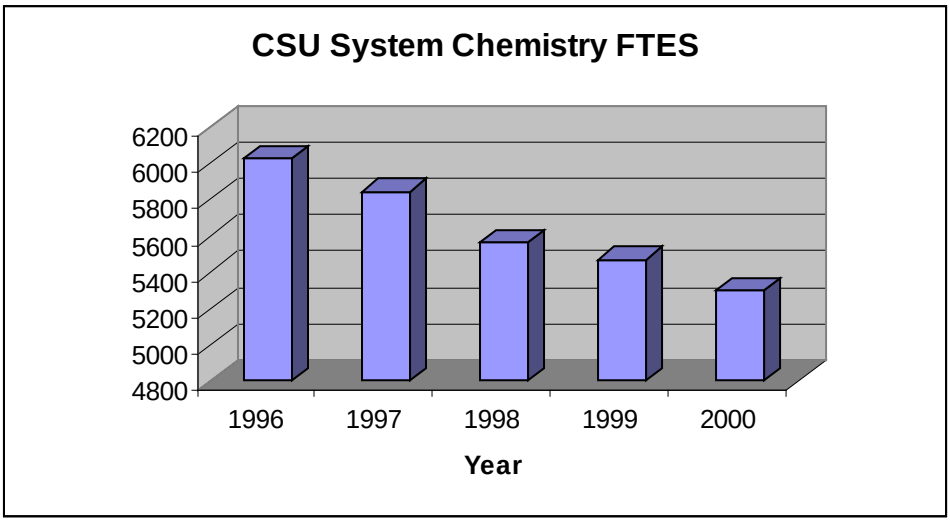
Quality scholarship, service and teaching

As mentioned earlier in this document, the faculty member that we hire will have many expectations. (S)he must be an accomplished and active scholar and must be willing to serve the campus and the community. But the primary requirement will be excellence in teaching. The new faculty member must be capable, willing and eager to teach the diverse students at CSUH. The new faculty member must strengthen the capacity of our Department to educate its students with special regard to critical thinking skills.

Attachment B

VI. Quantitative Evidence **Department:** Chemistry

			Fall Quarter				
	Category	Item	1997	1998	1999	2000	2001
A.	Enrollment History *(majors include Chemistry and Bio-Chem)*	Number of majors	90	95	110	111	101
		Undergraduate	75	80	87	98	87
		Graduate	15	15	23	13	14
		Chemistry FTES generated	162.14	166.00	184.67	175.33	161.60
		Number of sections offered	36	35	35	34	37
		Average section size	25.19	27.23	28.71	27.38	24.20
		Number of students on wait list					
		Degrees Granted Prev Year	12	34	11	23	22
		Undergraduate	10	27	7	21	15
		Graduate	2	7	4	2	7
B.	Staffing	Headcounts of TT Faculty	10	10	10	8	8
Data Source :		FTEF of TT Faculty	10.00	8.00	9.00	7.00	7.00
State Controller's Data		FERP FTEF	0.00	1.00	0.67	0.67	0.67
Base as of 11/1/01		Total TT FTEF	10.00	9.00	9.67	7.67	7.67
		Lecturer FTEF	2.07	1.33	1.07	2.93	2.13
		Total FTEF	12.07	10.33	10.74	10.60	9.80
		% FTEF that is Lecturer	17%	13%	10%	28%	22%
From APDB Chancellor's		Total Teaching FTEF	11.88	9.75	10.45	9.29	9.08
Office Workload Reports		% FTES taught by Part Time	26%	25%	15%	42%	34%
Excludes administrative							
and other support time							
C.	Capacity Utilization	SFR for Full Time Faculty	12.62	19.12	18.65	18.52	18.23
		SFR for Part Time Faculty	16.53	12.89	12.37	19.16	17.00
		Total SFR	13.65	17.03	17.67	18.86	17.80
		System SFR	18.00	16.80	17.00	16.90	na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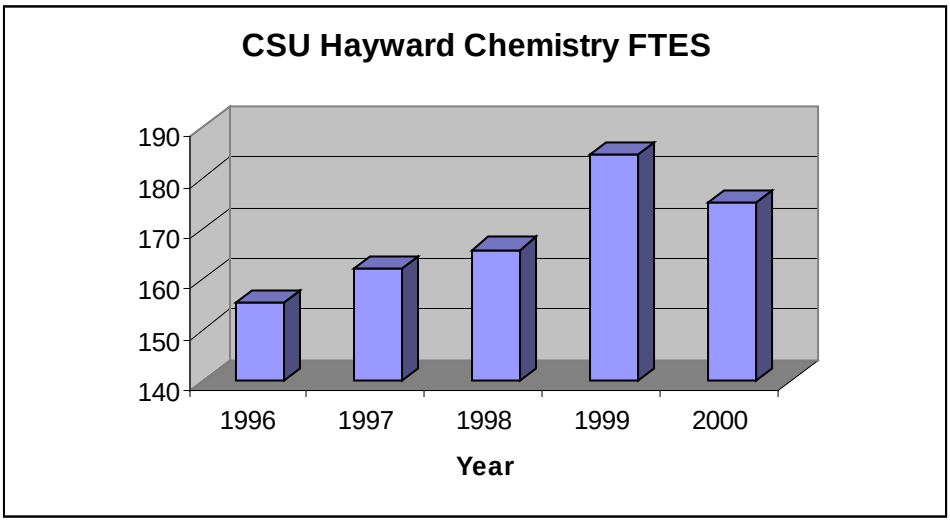
CSU Hayward Chemistry FTES
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Memorandum
Department of Chemistry and Biochemistry

Date: March 25, 2002

To: Michael Leung, Dean, School of Science

From: Rich Luibrand, Chair, Chemistry and Biochemistry

Subject: Request for Tenure Track Faculty Position

The Department of Chemistry and Biochemistry requests authorization to hire a tenure track faculty member during the 2002-2003 academic year. The request is for a Physical Chemist whose specialty is materials science. The new faculty member should have a strong desire to teach a broad range of courses, including General Chemistry, Quantitative Analysis, Physical Chemistry, Inorganic Chemistry, Chemical Thermodynamics, The Chemical Bond, and Advanced Topics in Physical Chemistry. The Department has the need for specialists in nanotechnology, electrochemistry, or biological applications.

Enrollment Growth

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During the same five-year period (1997-2001) the total FTEF has decreased by 19 percent, resulting in a thirty percent increase (from 13.65 to 17.80) in total SFR for the period. The corresponding SFR increase for full time faculty (from 12.62 to 18.23) reflects a forty four percent increase in workload during this time, not counting the increase in committee work. The Department SFR is higher than the System SFR, even though a chemistry program is more "labor intensive" due to the need to

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The American Chemical Society requires that courses for the certified degree program should be taught by regular full time faculty. The Department requires a Physical Chemist to teach several upper division courses in physical and inorganic

chemistry. Without a new Physical Chemist the Department is in danger of losing its accreditation.

Balance profession preparation with academic education

An important goal for all of the courses offered by the Department is to increase the abilities of our students in critical thinking and problem solving skills. It is likely that the Physical Chemist that we hire will teach Introductory Chemistry, General Chemistry, and Quantitative Analysis, in addition to the upper division and Graduate classes. Because chemistry is the "central science" these courses represent a required component for many degree programs such as Biology, Physics, Geology, and the Minor in Chemistry.

Meeting the needs of general education

The Department of Chemistry and Biochemistry has the goal of teaching all of its General Education courses with regular faculty, rather than part time lecturers. We are in need of several new appointments to meet this goal.

Balance "high growth" with "prestige" programs

The B. S. Degree in Chemistry is a program that is accredited by the American Chemical Society. The rapid shrinking of our regular faculty has placed that certification in jeopardy, since the required courses should be taught by tenure-track faculty. We can no longer meet this obligation and are at risk of losing this prestigious degree.

Seeking to meet the demands of future students

The areas of specialization requested represent some of the newest and hottest areas of modern chemistry. We have never had faculty members with these areas of expertise. These areas have been requested because of the likelihood that students trained in these areas will be especially valued when they seek employment.

Quality department and school plans to absorb and use new faculty

The skills of this new hire will be in demand by both our Department and other units in the School of Science. It is likely that the new hire will eventually become the instructor and coordinator of the General Chemistry program that is a requirement in several other departments. We need to have our finest teachers in this program, since these freshman and sophomore students are precisely those who have not yet mastered

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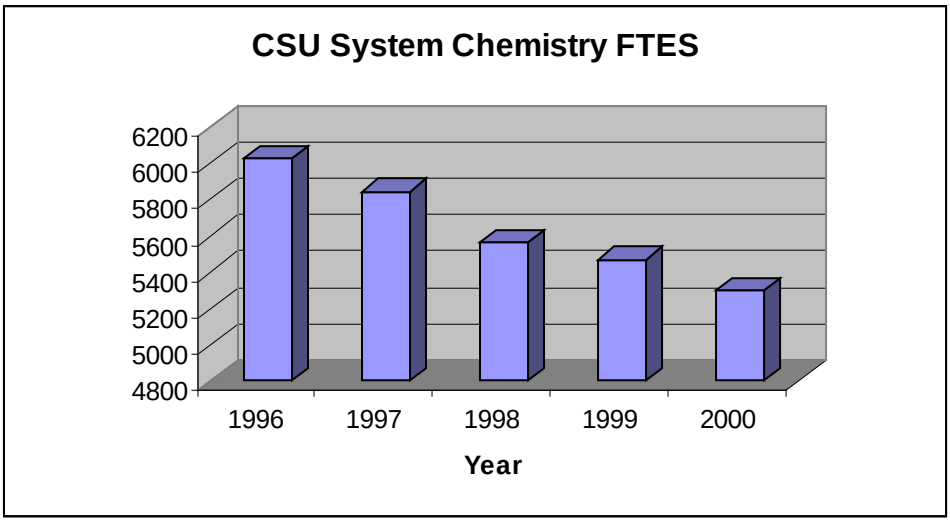
CSU System Chemistry FTES
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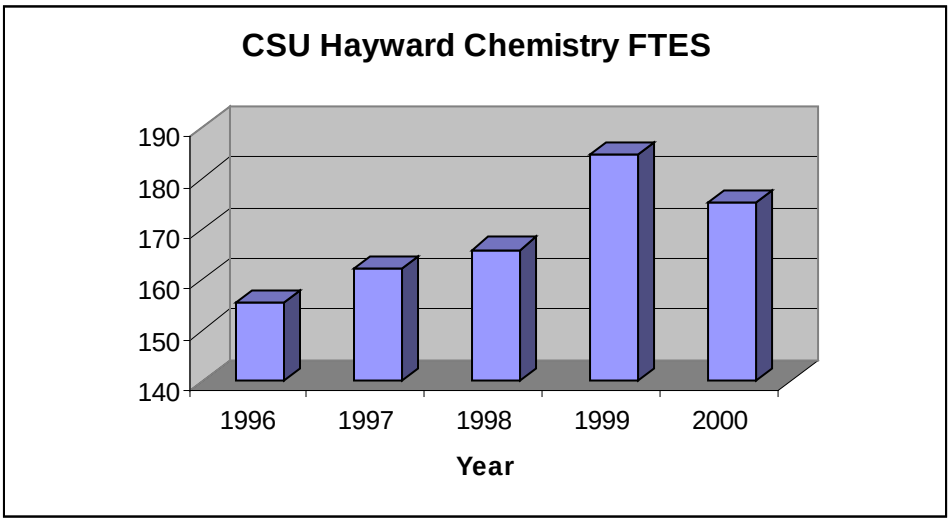
CSU Hayward Chemistry FTES
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CAPR Five Year Program Review

2007

Department of Chemistry and Biochemistry

Part 2. Five Year Plan (Amended)

a. Curriculum

1. The undergraduate majors program

As described in the Self Study, the number of Chemistry and Biochemistry majors has been rising steadily during the last five years. The department FTES has also risen significantly, and part of the increase is due to growth in our service departments, most notably Biological Science and Nursing and Health Science. In proposing changes to our curriculum, we are mindful of the potential impact not only on our majors, but also on the other science students who take our courses.

The results of assessment efforts indicate that the majority of our majors are successfully learning central concepts and skills in the chemistry and biochemistry areas. Where our assessment program has utilized a standardized American Chemistry Society (ACS) exam (in organic chemistry), our majors have scored near the national average over the last four years. We hope to maintain our current student success and improve upon it by maintaining a solid curriculum and upgrading it to match the advances in chemistry and biochemistry that will continue over the next five years.

Recent modifications of the BA Chemistry degree and development of the BA Biochemistry program have provided opportunities for enhancing our curriculum. Both degrees are designed to provide a basic chemistry and/or biochemistry curriculum but also leave room for a strong minor in another field. With the demand for graduates with interdisciplinary skills on the rise, we see these BA degrees as providing students with a means for obtaining a broad background that will enhance opportunities in the workplace. Building on the idea of a broadened degree program, we are planning to develop some specific options for our BA degree programs. These include BA degrees with an Option in Chemical Education and a BA Biochemistry degree with an Option in Biotechnology.

Proposed BA Chemistry and BA Biochemistry, Option in Chemical Education degrees. The idea for these degree programs originated with Dr. Jason Singley, a College of Science (COS) faculty member who works in the area of Science Education and collaborates with members of the Department of Teacher Education. The new programs would be developed to serve students who plan to go into a Teaching Credential Program after graduation with the goal of becoming high school chemistry teachers. The degrees would require a solid complement of chemistry and/or biochemistry courses similar to those currently required for our BA degrees and also require the courses in biology, physics, math and environmental science that serve as the breadth requirements for the Single Subject Matter program for future high school chemistry teachers.

Proposed BA Biochemistry, Option in Biotechnology degree. The large concentration of biotechnology and pharmaceutical companies in the Bay Area provides a rich source of job opportunities for CSUEB chemistry, biochemistry, and biological science majors. The continued strength of these industries accounts in part for the

popularity of our BS Biochemistry degree. We need to continue to introduce our students to theoretical knowledge and lab skills that prepare them for these fast-paced industries.

Recently, our department collaborated with the Department of Biological Science in developing a Biotechnology Initiative (submitted to the CSUEB Advancement Office as a vehicle for soliciting additional funding for biotechnology instruction). The Initiative describes a joint plan for increasing emphasis on biotechnology in our respective curricula. As part of the Initiative, the Chemistry and Biochemistry Department proposed establishing a BA Biochemistry, Option in Biotechnology degree program. This degree would retain the emphasis on chemistry and biochemistry of the current BA Biochemistry program and would also strengthen areas of training relevant to biotechnology. We plan to implement the new degree whether or not outside funding is obtained.

Additional proposed requirements to be included in the BA Biochemistry degree to create the Option in Biotechnology are Instrumental Methods of Analysis (Chem 4240), Principles of Genetics (Biol 3121), Molecular Cellular Biology (Biol 4455) and two new courses to be developed. The new courses include a two unit "Selected Experiments in Biotechnology" laboratory course and a 3 unit "Biotechnology Seminar" course to be offered jointly with the Biological Science Department. Students may also be required to take another elective course to be selected from a list of biochemistry and biology courses related to biotechnology.

We expect to submit the new BA degree options for approval within the next two to three years. We recently initiated discussions with Dr. Jason Singley of the Department of Physics and Dr. Catherine Reed of the Department of Teacher Education and plan to move forward on developing the Option in Chemical Education degrees in the near future. We hope to submit the new biotechnology degree option for approval within the next two years. The department Courses and Curriculum Committee, along with the Chair, will assume responsibility for completing the degree option proposals. Dr. McPartland and/or the new biochemistry faculty member will develop the biotechnology laboratory course.

The cost of the Option in Chemical Education proposals should be minimal whereas the Option in Biotechnology degree will incur the cost of some small equipment and supplies for the new "Selected Experiments in Biotechnology" course.

Develop Joint BA Chemistry / Business Degree. The local chemical, pharmaceutical and biotechnology companies all employ graduates with business degrees. These industries are eager to find individuals with science knowledge for their management and marketing positions. A combined degree would give graduates an advantage in the hiring process and on the job. Within the next several years we plan to initiate discussions with the Departments of Management and Marketing & Entre-preneurship to explore the possibility of developing a joint BA Chemistry/Business degree.

Eliminate the Major Elective from the BS Chemistry, Option in Forensic Science Degree. This degree has a very high unit requirement, up to 187 total. Because of the interdisciplinary nature of the degree, most of those units are necessary. However, the major elective does not add significantly to the quality of the degree. Elimination of these units will create a more manageable degree program without taking away from student training.

Modernize General Chemistry Laboratories. As a department with several major programs and a significant service component, e.g. for Biological Science, Physics, Environmental Science and Engineering, we try to frame our major offerings in terms of the needs of both our majors and the service groups, where appropriate. At the lower division level, General Chemistry is taken by all of the Chemistry and Biochemistry majors and by the other science majors listed above. Quantitative Analysis is required for the BS Chemistry and Biochemistry majors, the Chemistry minor and by one option in the Biological Science program. As interest in chemistry and biological science has increased in recent years, enrollments in both General Chemistry and Quantitative Analysis have increased significantly. We are to the point of not having laboratory space in which to run any more sections of these courses without impacting our other classes.

At the same time that enrollments are increasing, we see a need to modernize our General Chemistry laboratories. We would like to upgrade the small equipment in the labs and make computer analysis of data routine, when appropriate. This presents a challenge to the department in terms of cost and to our instructors and staff because of the large number of lab sections that are offered at the same time. A goal for the next five years is to improve the General Chemistry laboratory experience by finding creative ways to finance new equipment and teach our beginning chemistry students to use computers for analysis of scientific data.

Our current plan is to rotate General Chemistry students through our existing computer lab for data analysis using Excel software. We will also introduce graphing calculators attached to chemistry probes for selected General Chemistry experiments. The graphing calculators will also be used for some of the experiments in Quantitative Analysis and General Biochemistry Laboratory. We also want to change the students' data reporting method in General Chemistry to be more in line with the American Chemical Society recommendations. In particular, this would mean adopting the use of laboratory notebooks rather than the worksheet model currently being employed. Our new faculty member, Dr. Danika LeDuc, has taken on the responsibility of teaching General Chemistry and coordinating the laboratories. In collaboration with the department faculty and staff, she will work to implement the proposed changes.

Maintain and Upgrade Biochemistry Offerings. Over the last few years as the enrollments have grown in the biochemistry area, it has been possible to routinely offer several upper division biochemistry electives. We have also started offering each of our biochemistry labs twice a year, as opposed to the once a year norm five years ago. We expect the upward trend in biochemistry majors to continue based on the strength of the biotechnology industry in the Bay Area and the continued interest of our students in the

pre-professional health fields (e.g. pre-medicine, pre-dentistry, pre-pharmacy). Because the pace of new discoveries and method development in biochemistry and biotechnology is so rapid, we must anticipate the need to add new topics to the course syllabi for all the lecture courses in the biochemistry program, but especially for the major elective courses. These currently include Protein Structure, Nucleic Acid Chemistry, and Major Organ Biochemistry. Plans are already underway to add more computer-based structural analysis to the Protein Structure course. Dr. Monika Sommerhalter is leading this effort. We also hope to add recent topics in areas such as RNA interference and genome analysis to our Nucleic Acids course and to include more bioinformatics exercises. Our new tenure track Biochemist will hopefully handle upgrades in this course and/or the Major Organ Biochemistry course.

The rapid pace of method development means that we need to continually revise and improve our biochemistry laboratory curriculum. Most of the new equipment needs are relatively modest and can be handled by College of Science Program Enhancement funds. However, we do have a strong need for additional HPLC equipment to improve our teaching of this technique in the biochemistry laboratories. Knowledge of HPLC is in high demand in the biotechnology and pharmaceutical industries. We would also like to utilize fluorescence assays in our laboratories and this will require the acquisition of a fluorimeter or possibly several small fluorimeters.

Recently, Drs. Sommerhalter and Kotchevar co-authored a proposal to the Dreyfus Foundation outlining a plan for coordinating the teaching of HPLC throughout our curriculum, with simpler experiments proposed for the lower level courses such as Quantitative Analysis, and more complex experiments proposed for upper division and graduate lab courses. As part of the proposal, funds were requested for an additional small HPLC apparatus to complement those we currently use in the General Biochemistry lab course. Whether or not this proposal is funded, it is a department goal to improve the teaching of HPLC in our curriculum by maintaining and upgrading our equipment and by improving and coordinating the laboratory experiments. Over the next three years, we expect to see significant improvement. This effort will be coordinated by Drs. Sommerhalter and Kotchevar.

Finally, we do plan to introduce fluorescence assays into the biochemistry laboratories. Several members of the department are interested in obtaining a high quality fluorimeter both for teaching and research uses. Within the next year the department will submit an application to the National Science Foundation CRIF program requesting funding for a fluorimeter. Dr. Kotchevar will spearhead this effort. If outside funding is not obtained within a year or two, we will use department funds to gradually add small fluorimeters to the biochemistry laboratories. These will also be available for use in other courses, such as the Bioanalytical and Forensics Lab course, Instrumental Methods of Analysis and Physical Chemistry Laboratory.

Increase Units for Advanced Biochemistry Laboratory Course (Chem 4431). This course was originally designed as a two unit addendum to the four unit General Biochemistry laboratory course. However, in order to cover the large number of

biochemistry techniques currently in routine use and to be able to finish the lab experiments in the allotted time, we plan to increase this to a 4 unit course.

Addition of major electives in organic and physical chemistry. While there are fewer Chemistry majors than Biochemistry majors (46 versus 90 in Fall 2006), the number of Chemistry majors has increased about 18% over the last five years. One of our three undergraduate chemistry programs, the BS Chemistry degree, is accredited by the American Chemical Society (ACS). As the number of Chemistry majors declined in earlier years, our advanced degree offerings tended to reflect the minimum requirements for ACS accreditation. With the arrival of Dr. Michael Groziak four years ago, we revived our Advanced Organic Chemistry elective course. We now plan to add several more advanced chemistry electives to the curriculum.

Because of the recent increases in the Master's degree program, enrollments in advanced 4000-level chemistry courses also acceptable for the Master's degree have increased significantly. Advanced Organic Chemistry and Advanced Inorganic Chemistry now enroll 25-35 students. We hope to increase the elective offerings in the organic and physical areas by developing new courses that will attract both advanced undergraduates and graduate students. In the organic area we plan to resurrect our Synthetic Organic Methods laboratory course and offer a new Bioorganic Chemistry lecture course. These courses will be taught by Professors Groziak and/or Kotchevar. We expect to re-establish the Synthetic Organic Methods course within the next two years. The Bioorganic course will be developed over the next five years.

In the physical chemistry area we hope to offer a new Nanochemistry and/or Biomaterials course. Nanotechnology has become a very important tool in chemistry and biochemistry. A course in this area would be very beneficial to our students. We have included Nanochemistry and Biomaterials as areas of interest in our advertisements for the tenure track physical chemist search we are currently conducting and many of the applicants have expertise in these areas. We hope to hire an individual qualified to teach a Nanochemistry / Biomaterials course. A possibility is to cross-list this course as both 4000 and 6000 level.

2. The General Education (GE) Curriculum

Add an Activity Component to our GE Popular Topics Course. To provide GE students with more hands-on opportunities in the chemistry classroom, we plan to substitute a one hour "activity" component for one of the lectures in our Popular Topics in Chemistry course (Chem 1000). Short lab exercises and class discussion will be employed during the activity hour to develop the topics covered more fully. Chem 1000 is often taken by students interested in elementary school teaching and adding an activity component should keep their interest and arm them with tools they can use to teach in the classroom.

Increase Upper Division GE Offerings. The university recently added an upper division science requirement (B6) to the GE package. This has led to increased demand

for 3000 and 4000 level science GE courses. Our "The Making of Wine" course (Chem 3010) fits nicely into this category, and we plan to increase the number of lab sections for the course as demand increases. We also plan to design additional course offerings. Two topics that should attract non-science majors and serve as vehicles for teaching basic chemical principles include Alternate Energy Sources and Food Safety. Over the next five years we plan to develop courses in these areas. The courses will be 4 units; the format for one of the courses will be 4 hours of lecture, the other will have 3 hours of lecture and one activity hour. This latter format will permit GE students to get some hands on experience with chemistry. The Department Courses and Curriculum Committee in collaboration with the Chair will take the responsibility for course descriptions and applications for GE status. The Chair will solicit instructors to develop and teach the courses.

3. Concord Campus

Teach the Pre-Nursing Chemistry Series on the Concord Campus. CSUEB recently established a Concord arm of the Nursing Program, and students are now able to do the entire Nursing Program on the Concord campus. The Concord Dean has negotiated an agreement with the local community colleges to allow CSUEB to offer the Pre-Nursing curriculum as well. A recent state bond approved by California voters has supplied funding to upgrade the Concord campus laboratories for the Pre-Nursing lab curriculum. We plan to offer Basic Chemistry I and II (Chem 1601-02) on the Concord campus within the next year. Modifications of the labs are currently being planned, and we expect to offer the Chem 1601-02 series for the first time in 2008-2009.

4. Master's Degree Program

Develop an M.S. Chemistry, Option Biochemistry Non-Thesis Degree Program. The department currently offers a Master of Science in Chemistry degree with three possible options: a research-based Chemistry Option (Plan A), a non-thesis Chemistry Option (Plan B), and a research based Biochemistry Option. The recent upsurge in students joining our Master's degree program has lead to an increase in the number of graduate students interested in biochemistry. Many of these students prefer the non-thesis option but are not particularly interested in some of the courses required for this (Plan B) option. There now appears to be sufficient student demand to justify creation of a non-thesis biochemistry option (Plan B) under the MS Chemistry degree program. This will provide the symmetry currently missing in the program by allowing us to offer MS Chemistry, Option Biochemistry degrees under both the thesis (Plan A) and non-thesis (Plan B) programs. As of Fall 2007, there were 56 students enrolled in the MS program, up from 21 in Fall 2002; about half of these students are interested in biochemistry.

Over the next three years, we plan to develop and introduce several new 6000-level courses relevant to biochemistry (and chemistry) to serve as requirements in a new Plan B, Option Biochemistry degree program. These will include courses in Molecular Spectroscopy and Physical Biochemistry and a two unit Advanced Topics Seminar.

These courses will also serve as electives for the MS Chemistry degree programs currently in place. We will also offer the Advanced Topics in Biochemistry (Chem 6410) course more frequently and provide a diverse variety of topics. MS Chemistry students can now take this course twice, each time with a different topic, and we will continue this policy for the under the proposed Plan B, Option Biochemistry program. The number of sections of the Protein Chemistry Techniques lab course (Chem 6430) will also be expanded to meet increased student demand. Dr. Kim and our new physical chemist will develop the Molecular Spectroscopy and Physical Biochemistry courses. The Advanced Topics Seminar course will be rotated through the faculty. New sections of Chem 6410 and Chem 6430 will be handled by Drs. Sommerhalter, LeDuc, McPartland and the new tenure track biochemist.

By the end of the next five year period, we plan to have the new M.S. Chemistry, Plan B Option Biochemistry degree in place. In addition to the graduate biochemistry courses now offered and those to be developed, MS Chemistry, Plan B Option Biochemistry students will be able to take our advanced 4000-level biochemistry elective courses, the Selected Experiments in Biotechnology lab course, the new Bioorganic Chemistry course and 6000-level courses in Cell Biology and Advanced Molecular Techniques offered by the Biological Science Department.

5. Outcomes Assessment Plan

In order to better determine whether our programs are achieving their goals, the Department Assessment Committee will make some changes to our Assessment Plan. We want to ensure that we have useful feedback on improvements to our curriculum and programs. First, we plan to implement exit surveys for graduating seniors and MS students in order to assess our program's impact on the achievement of their career goals. Secondly, we will reduce the number of courses assessed in our plan from all possible electives to the core courses taken by the entire degree program cohort. These courses will be chosen as the exit or capstone courses of their respective discipline. This data will allow us a more consistent year to year comparison of each program's overall student learning outcomes. Finally, we will revise the MS assessment plan to include measurable outcomes. The MS program has been difficult to assess in terms of overall outcomes because the students have a wide variety of course options and there are fewer core courses. We will use the placement exams as an entry indicator and the comprehensive review exam as an exit indicator. We will also develop a rubric for measuring independent research skills to assess either their thesis (Plan A option) or comprehensive review paper (Plan B option).

b. Students

1. Enrollment

We anticipate that the number of students majoring in our degree programs will increase over the next five years. This would continue the trend observed since our last

review and the University enrollment increases in all segments (first-time freshmen, transfer students, and graduate students). The Fall 2007 enrollments support this expectation; we saw a noticeable increase in the number of freshmen enrolled in General Chemistry who declared themselves Chemistry or Biochemistry majors. We also expect the total enrollment in Chemistry and Biochemistry courses to continue to increase. In the past five years, we have seen growth in our service courses primarily through increases in the number of students majoring in Biological Science or Nursing and Health Science. Additionally, we have seen heightened demand for our courses from students pursuing careers in medicine, dentistry, optometry, and pharmacy. Finally, increasing enrollment university-wide will translate into increased demand for our general education courses.

2. Programs to Reach New Populations

We anticipate starting two programs that would reach new student populations in the next five years. First, as mentioned above, we envision the formation of B.A. Chemistry and B.A. Biochemistry, Option in Chemical Education degrees. To accomplish this goal, we will work closely with Dr. Jason Singley and the Department of Teacher Education. Efforts to put the Chemical Education options in place have already begun, and the new programs should be available for students within the next two to three years.

Formation of the second program, a dual-degree in Chemistry and a Business major such as Marketing & Entrepreneurship or Management, constitutes a more long-term goal. Our first step in accomplishing this goal would be to initiate a dialogue with the respective department heads in the College of Business and Economics over the next two to three years. This new program would benefit greatly from the strong reputation of this College. Having additional coursework in chemistry and biochemistry would give program graduates an advantage for employment in the pharmaceutical, drug design, and biotechnology industries, particularly in the Bay Area and Southern California. From the perspective of students majoring primarily in Chemistry, additional coursework in the College of Business will also be advantageous for career advancement. In fact, the ACS Careers Blog recently posted an article citing the need for new hires to be conversant in the different disciplines of science as well as the basic principles of business (ACS Career Blogs, December 17, 2007.)

3. Changing Career Opportunities for Students

Career opportunities for Chemistry and Biochemistry graduates are often changing with the advent of new technologies and new research focuses. The American Chemical Society anticipates growing employment for chemists and biochemists in the biotechnology, natural products chemistry, bioinformatics, and biofuels/alternative energy sectors (see for instance, “Biotech’s Perfect Storm”, C&E News, April 30, 2007, Vol 85:38-40). Large-scale openings in chemistry-related jobs in government are also expected (i.e. Patent and Trademark Office, DEA, EPA, Department of Agriculture, etc.) because of anticipated mass retiring of the baby boom generation (“Overlooked

Opportunities in Government", C&E News, March 14, 2007, Vol 85:47-50). Additionally, there is a statewide and nation-wide shortage of teachers and specifically those able to teach high-school level science.

It is clear that the job market of the future will require flexibility and a diverse skill set. In addition to a strong foundation in chemistry and biochemistry, our graduates will need skills in communication (written and oral), computation and data analysis, literature-based and bench research, and instrumentation. Our current undergraduate and graduate degree programs are already designed to develop these skills in our students. However, we anticipate changes at both the program and course level in the next five years to specifically address the foreseen job market.

At the program level, we envision four major areas of change. As mentioned above, we hope to address the shortage of qualified chemistry teachers by offering B.A. Chemistry and B.A. Biochemistry, Option in Chemical Education degrees. To assist our students in gaining business acumen for career in advancement in today's industry jobs, we will offer a joint degree between the Chemistry and Biochemistry and Marketing or Management departments. To help our students capitalize on the booming growth in biotechnology, particularly in the Bay Area, we will offer a B.A. Biochemistry, Option in Biotechnology degree. At the graduate level, we envision the formation of an MS Chemistry, Option Biochemistry Plan B degree, which will be particularly attractive to students already working in the local biotechnology industry looking for career advancement.

As demand for our biochemistry degree programs and courses grow, we will expand our program offerings in terms of number of courses and sections offered. For instance, we will offer a joint Biotechnology Seminar course in conjunction with Biological Science and a Selected Experiments in Biotechnology lab course. We will expand our biochemistry offerings at the graduate level to support the new M.S. Chemistry, Biochemistry degree option. We also plan to decrease the number of units required in our B.S. Chemistry, Option in Forensic Science degree, to attract more students to what should prove a very popular degree option based on current student interest in this field.

At the same time, we want to prepare our students, both at the bachelors and masters level, for entrance into and success at a Ph.D. program. We foresee possible changes across the curriculum that would assist us in this goal. As mentioned above, over the next five years we plan to gradually augment our current upper division and graduate level offerings with new courses such as Synthetic Organic Methods Lab, Molecular Spectroscopy, Physical Biochemistry, Nanochemistry and/or Biomaterials, Bioorganic Chemistry, and an Advanced Topics Seminar. Equally important in preparing our students for Ph.D. programs, is providing them with research opportunities in which they learn laboratory skills and present their work at conferences and in papers. By hiring new faculty who will establish active research programs shortly after arrival, we will continue to increase the number of students who graduate with research experience.

Our faculty will modify the individual courses for which they are responsible to address the demands of the job market. At the level of General Chemistry, we plan to introduce more writing assignments and training in the maintenance of a proper laboratory notebook. Across the curriculum, faculty will integrate more assignments using computers for data analysis or specialty chemistry software. For instance, we plan to introduce the use of Excel in the General Chemistry sequence, earlier than its current introduction in Quantitative Analysis. Biochemistry courses will make use of computer tutorials and the ample software and web resources related to nucleic acid and protein sequence and structure. Finally, we plan to continuously update our laboratory courses so that the instrumentation and techniques with which our students are familiar equip them for the job market and graduate programs. Specific examples of such modifications include interest in computerized pH/temperature probes and UV spectrophotometers to be used in General Chemistry, Quantitative Analysis, and Biochemistry laboratory courses, more HPLC experiments in the Biochemistry laboratory, and updated equipment throughout the Organic and Biochemistry sequences.

4. Advising and Retention

Advising and retention are both high priorities for our department. Our full-time faculty split advising duties at the undergraduate level by each taking a portion of the alphabet. This gives our students a consistent "go-to person" throughout their time in the department, regardless of the degree option with which they eventually graduate. At the graduate level, we have a dedicated graduate coordinator who administers placement exams and meets with students regularly to ensure that they make consistent progress towards graduation. Additionally, all graduate students have an individual faculty advisor. Plan A students conduct research in a faculty member's lab and get extensive mentoring, not only with respect to their research project, but also regarding course selection and career goals. This mentoring relationship is also an important aspect of advising and retention for our undergraduate students who conduct research. Additionally, Plan B MS students are assigned a faculty member who guides them toward the completion of their final literature review paper.

We always seek new ways to improve the effectiveness of our retention and advising activities. One change that would likely benefit our students would be to have a dedicated undergraduate coordinator, with assigned time for the task, who could help with general questions, freshmen advising, and with students considering transferring to CSUEB or changing majors. Increasing our number of faculty will lead to greater research opportunities for our undergraduate and graduate students, allowing for closer, one-on-one mentorship of a greater proportion of our students.

It is generally agreed upon by department faculty that more time should be assigned for advising our Plan B graduate students and our research-active undergraduate and graduate students. Faculty members serve as instructors for the various research courses these students take. However, they are not assigned credit for teaching these individual courses based on the number of courses or students taking them, but rather receive a maximum of 2 WTU /academic year. This allocation does not nearly reflect the

amount of time required, particularly with our vastly increasing graduate student population. Finally, we anticipate the need for more faculty support to learn "the ropes" of advising, especially for new faculty.

4. Resources Needed to Better Serve Our Students

Clearly, our growing student population would be better served with increased resources in terms of personnel, space, and equipment. In terms of personnel, our students would greatly benefit from two full-time administrative staff to cut down waiting time for students with registration problems. The hiring of two additional tenure-track faculty this year and more anticipated during the next five years will increase student contact with full-time faculty as well as provide a greater number and breadth of research opportunities. The specific research expertise of these faculty members will allow them to develop specialized courses at the upper-division and graduate levels to increase our course offerings.

Students would directly benefit from an increase in space in several ways. First, more teaching laboratory space would allow expansion of our offerings as enrollments increase. We are currently at capacity during the Winter and Spring quarters. More space would also obviate the need for multiple students to share lockers, as has become necessary in the last few years. When students are assigned their own lockers, they take greater ownership and care of their equipment and glassware and learn good laboratory technique. Second, we need more research space to accommodate the increasing number of students interested in doing research projects. Third, our desire to continuously update our curriculum requires the acquisition of cutting-edge instrumentation (discussed further in Resources). We need space to house these instruments, whether in teaching or research laboratories, as well as funding to cover maintenance costs and service contracts. Finally, our ability to advise students and hold effective office hours would be enhanced if more faculty members had their own offices.

5. Department Communication

The Department of Chemistry and Biochemistry as a whole puts great emphasis on communication within the faculty and with students. Communication is facilitated greatly by the extremely active role the faculty members play in advising and mentoring students in both the traditional sense and as research mentors. Additionally, full-time faculty members teach lab courses at all levels throughout the curriculum. These teaching assignments allow for increased student-faculty contact both in terms of time (lab sections meet for a minimum of 2.5 hours once a week with the majority meeting more) and in lower student-faculty ratios (24 or fewer students per section).

c. Faculty

The FTES for the department has steadily increased over the last five years, from 176 in the Fall of 2002 to 243 in the Fall of 2006. The number of course sections offered

has also increased from 37 in the Fall of 2002 to 65 in the Fall of 2006. An increase in full time tenure track faculty is needed to maintain the quality of our courses and stability of our programs. During the past five years, three faculty members have completed the Faculty Early Retirement Program (FERP) and one other faculty member is in his second year (of five maximum) of the FERP program. Sadly, Dr. Larry Scheve, a biochemist in the department, passed away suddenly in the summer of 2006. In the period since the last five year review, two organic chemists, two physical chemists, and one biochemist were hired. Currently there are seven full time tenure track faculty members and one FERP member in the department. Two tenure track faculty searches are currently in progress, one for a physical chemist and one for a biochemist.

The American Chemical Society requires that courses for the certified BS Chemistry degree program be taught by regular full time faculty. To ensure that our upper division and graduate courses are taught in accordance with ACS requirements, there will be a need for an additional faculty member in the area of physical, analytical, materials, or inorganic chemistry within the next five years. The current search for a physical chemist has broad requirements in terms of the area of specialization. Depending on the discipline of the new physical chemist, we will need another chemist who has an area of expertise which would complement that of the department. If enrollments in the biochemistry area continue to increase, we will also need an additional biochemist within the next five years. Currently the Department Chair is a biochemist, which limits the number of courses she can teach. There is one other tenure track biochemist in the department and we will hopefully hire another this year. However, even after a new biochemist is hired, the department will continue to rely on part-time instructors to teach some of the upper division biochemistry courses. In addition, because the majority of the department's majors are in Biochemistry, there is a need for more biochemistry faculty to supervise graduate and undergraduate research. If an MS in Biochemistry is introduced (see Curriculum Plan above), the need for research mentors in biochemistry will grow even higher. Finally, there will be a need for an additional organic chemist when Dr. Rich Luibrand completes the FERP program in three years.

To maintain ACS accreditation for the BS Chemistry program, we are required to provide opportunities for undergraduate research. Participating in undergraduate research is critical for students who wish to go on to graduate or professional programs. Conducting independent laboratory research is also important for students wishing to gain employment in the chemical or biochemical industry. The dramatic increase in the number of students enrolled in our MS program has also lead to a demand for research advisors. Only full time tenure track faculty members are able to provide such opportunities and we therefore carefully consider the potential for engaging our students in research projects during a tenure track faculty search. However, directing undergraduate and MS research is labor intensive and requires a large time commitment from faculty although it does not diminish their teaching load. Because faculty must train students in experimental methods and techniques, and supervise them in potentially hazardous laboratory situations, the number of students a faculty member can reasonably take on is limited. To accommodate as many student researchers as possible, the number of research active faculty must remain high.

d. Resources

1. Staff

Currently the department has one and a half permanent staff positions for the department office. This level of staff support has become inadequate due to the increase in student enrollment and to the additional administrative computer and paperwork duties that the office staff have become responsible for over the last five years. To alleviate some of the stress on the staff, the Dean has temporarily increased the halftime staff position to three quarter time with year to year review of the continued need. The department faculty agree that the office needs two full time permanent staff members, at a minimum. The professionalism of the stockroom staff is critical to the ability of the department to maintain high standards in the teaching laboratories by careful preparation of chemicals and supplies for the labs. The stockroom staff are also relied on maintain the equipment and instrumentation needed for teaching and research. Continuing to hire persons who are knowledgeable about chemistry and chemical instrumentation, and are committed to learning to troubleshoot and repair the equipment and instruments is essential.

2. Equipment

The past five years has seen a growth in equipment and instrumentation available to the Chemistry and Biochemistry department thanks in a large part to grants obtained by faculty members and purchases made as part of start-up packages. We wish to continue this trend in order to keep our program current in a rapidly advancing field where knowledge of modern instrumentation has become a must for Chemistry and Biochemistry majors. There are several instruments the department would like to acquire for use in research and/or incorporation into teaching labs. A fluorescence spectrometer is one such example. This instrument is used in a variety of disciplines and has broad research applications. Fluorescence spectroscopy should be introduced into several advanced laboratory courses (instrumental analysis, biochemistry, physical chemistry) and could be used in multiple research projects. Several faculty members plan to submit a proposal to the NSF-CRIF program within the next year to obtain funds for a fluorescence spectrometer. The proposal will be written by members whose research would involve the instrument and Dr. Kotchevar will take responsibility for coordinating the effort.

There is also interest in obtaining two new probes for the NMR: a triple channel probe (C/H/N) for biochemists interested in structure elucidation of large macromolecules like proteins or RNA, and a dedicated $^{1}H/^{13}C$ probe for the organic chemists. The NMR users plan to apply for an NSF grant to purchase the additional probes. The department would also like to obtain a microwave synthesizer, a device for safely speeding up chemical reactions. This instrument would be used by several faculty members for research but would also allow more complex syntheses to be taught in the organic chemistry laboratory courses. Drs. Groziak and Andrews will take the lead in seeking funding for the microwave synthesizer. In addition, there is interest in acquiring

an LC/MS (liquid chromatography/mass spectrometer) which would be a valuable analytical instrument for both organic chemists and biochemists. This is a longer term goal and would again be funded by a grant written in collaboration by the potential users.

While acquiring new instrumentation is important, it is essential to provide for maintenance. Modern instrumentation has become extremely difficult for the lay person to troubleshoot and repair. Continuing service contracts on our instruments have proven to be the only way in which we can maintain reliable functioning instrumentation. However, these service contracts are not cheap and need to be renewed annually. The department will need additional funding to cover service contracts as new instrumentation and equipment is acquired.

In addition to state-of-the-art research equipment, new instrumentation is needed to maintain and enhance our teaching laboratories. A high priority is a new IR spectrometer for the organic teaching labs. This instrument is essential to the teaching of organic chemistry and is heavily used in the lab sessions. Parts and supplies for the IR spectrometer currently in use are no longer available from the manufacturer as they stopped providing support for that model a few years ago. We are essentially operating on borrowed time with the instrument. Because we have increased the number of sections of organic labs offered every quarter, there is also a need to purchase more melting point apparatuses and refractometers to outfit the increased number of laboratory rooms in which organic chemistry is taught. When the Synthetic Organic Methods lab is added to the curriculum, small equipment items, such as rotary evaporators, will need to be added to an organic laboratory classroom.

Plans to update the General Chemistry and Quantitative Analysis laboratory curricula include purchasing temperature/pH probes connected to modified graphing calculators. These would also be used in the biochemistry labs. Additional UV spectrometers are needed to handle increased enrollments in the General Chemistry and General Biochemistry labs, and many of the spectrometers in current use need to be replaced. Increased enrollments, plans for new classroom experiments and general wear and tear have led to the need to supplement small equipment items for the biochemistry laboratory. These include electrophoresis apparatuses, power supplies, pipetmen, cell lysis devices and microfuges. Other larger items needed to advance the biochemistry laboratory curricula include small fluorimeters, an imaging system for protein and DNA gels, and a plate reader to be used for ELISA assays and high throughput enzyme assays. The biochemistry teaching lab also needs a new classroom incubator and incubator-shaker.

Laboratory equipment is expensive. In the past, we have been able to upgrade classroom equipment through Program Enhancement Funds offered through the College of Science. We hope to have the opportunity to apply for these funds in the coming five years. Other smaller purchases will be made over time as the Department budget allows. For larger scale projects, we plan to apply for grant funds through the NSF-CCLI program.

3. Space

Greater research space is a critical need for the department as is more space for shared instrumentation. In order to attract new faculty, we must be able to offer them dedicated space to set up a research lab. This research space cannot be shared with laboratory teaching space. Although we realize this is a concern shared by most departments in the College of Science, the chemistry department is seriously lacking in dedicated research space. As mentioned above, we are currently in the middle of two tenure track searches. One of the two new faculty hires will be able to use half of lab S447 (the other half of which is occupied by another faculty member) but there is no space in which to place the second hire. For this and any future hires, the lack of space remains an enormous stumbling block.

Shared instrumentation space is also a growing necessity. Currently the NMR, GC-MS, GC-FID, AA, and two HPLCs occupy our shared instrument space. Other shared instruments are squeezed into teaching laboratories, which limits their utility for researchers except during off-hours. This situation also leads to disruption during lab classes when other laboratory courses or sections not meeting in that room need to use a particular instrument. In addition, extra space in the teaching labs is now in short supply. While we have plans to acquire new instruments, we desperately need accessible space to house them.

Finally, faculty members need to have private offices whenever possible. Our offices are typically shared among two faculty members. This becomes problematic as it is impossible to work in one's office when the other faculty member is there holding office hours, advising, or meeting with research students. Due to the experimental nature of our research and the need to supervise students in the laboratory, it is generally necessary for faculty to spend most of each day on campus. It therefore becomes difficult to work effectively with no place to concentrate without interruption.

4. Library

The library has been very supportive of our need for easily accessible databases for searching the chemical literature. A large range of science journals is available to us on-line and, with help from the Dean of the College of Science, the library provides access to the Web of Science. For journals to which CSUEB doesn't subscribe, the library's participation in the Interlibrary Loan Program has made obtaining articles an easily managed problem. Unfortunately, over the past five years, the library's budget has shrunk and journal subscription fees have increased leaving little room for the purchase of new books. We can borrow books through the interlibrary loan program and this works well for research, but often students in our courses can't wait for a book to be delivered from another library within the time frame of a 10 week course. It would be desirable for the library to be able to purchase more books on modern topics in chemistry and biochemistry, particularly in the areas of spectroscopy, drug design, chemical biology, proteomics, metabolomics, and nucleic acid chemistry.

5. Travel

Attendance at professional meetings and conferences is essential for faculty members to stay current in their fields. Conferences also provide opportunities for faculty members and their students to present research results. Such travel should be encouraged and supported. The College of Science has funds for faculty members for registration and/or travel to meetings and conferences. We need to increase awareness among our faculty of these possibilities.